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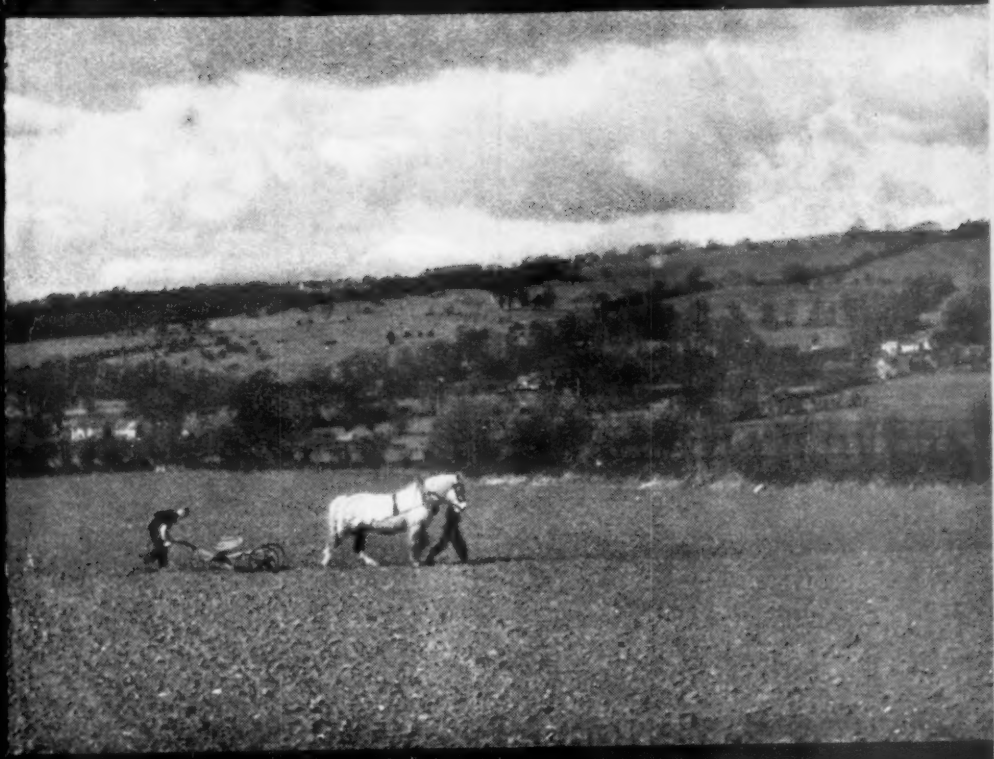

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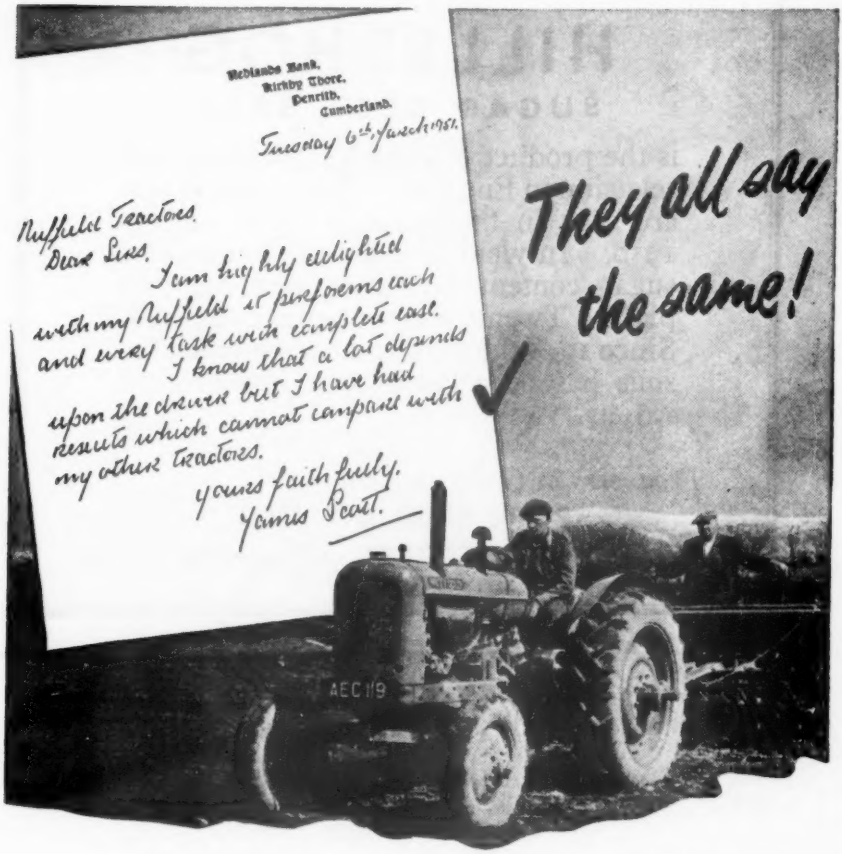

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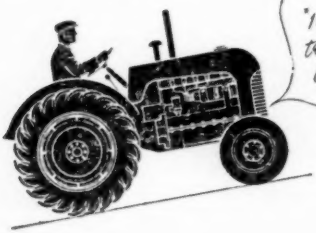

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Editorial Offices : St. Andrew's Place, Regent's Park, N.W.1 (*Phone* : *WELbeck* 7711)

VOL. LVIII No. 12 MARCH 1952

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AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVIII No. 12 MARCH 1952

KING GEORGE VI

1936 — 1952

IN all spheres of the nation's life, the memory of His Majesty King George VI will be revered for many years to come. But in none will " the remembrance of things past " be cherished more strongly than in farming circles wherein, despite the insistent cares and calls of State, he moved with knowledge and understanding. A farmer in his own right, he loved the land and knew both the disappointments and rewards attendant upon our oldest industry.

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THE COSTS OF PROTEIN IN HOME-GROWN FOODS

W. HARWOOD LONG, M.A.
Department of Agriculture, University of Leeds

The fundamental problem of growing sufficient cheap protein for stock is common to most farmers nowadays, but varies in detail from farm to farm. The results of studies at several centres concerned with agricultural economics are discussed here by Mr. Long. Another article on the same subject, by Dr. C. V. Dawe, of Bristol, will appear in next month's issue of AGRICULTURE.

FOR a decade after 1939, exhortations to use more home-grown foods in rations for livestock were made against a background of relatively cheap bought foods : to grow fodder crops on land which had always been devoted to such sale crops as wheat, barley or potatoes, almost certainly meant that the forfeited income from crops would be greater than the sum saved on bought foods. But for most of this period, the physical restrictions on the purchase of foods were so tight that animals like pigs and poultry, which depend mainly on concentrated feedingstuffs, had to be drastically reduced in numbers, and for the same reason, the average yield of cows in the dairy herds fell, too.

During these years, the concentrates fed per cow, and the average yield of milk, in the herds participating in the National Investigation in the Economics of Milk Production (Yorkshire province) were :

	1939-40	*1940-41*	*1941-42*	*1942-43*	*1943-44*	*1944-45*	*1945-46*	*1946-47*
Concentrates Fed per Cow (*cwt.*)	21.6	18.16	15.58	14.41	15.39	16.38	19.08	19.82
Yield per Cow (*gal.*)	632	599	576	564	566	594	599	621

The subsidy on bought foods was, therefore, much more effective in keeping down costs of production of livestock and their products than in encouraging wasteful feeding. The favourable ratio in the prices of bought foods, and the animal products into which they were transformed, resulted in a big increase in production of pig meat and eggs, and in a considerable improvement in milk yield per cow, as soon as more feedingstuffs became available.

During the last twenty months, conditions have changed again by the removal, at two stages, of the feedingstuffs subsidy. Average prices of dairy cake fed by farmers co-operating in the National Investigation into the Economics of Milk Production, have risen from £16 1s. per ton (August, 1948) to £33 1s. 6d. per ton (August, 1951), and this has added to the feeding problem which faces stock farmers. Previously, it generally paid them to feed to stock all the purchased foods they could acquire at controlled prices—the economics of feeding foods bought at higher than controlled prices need not be discussed here—but it was not as easy to decide how much land, which would otherwise grow crops for sale, should be given up to growing feedingstuffs. The additional problem that must now be solved is the extent to which it is preferable to reduce, or even to cut out entirely, purchased concentrates, the deficit being met with home-grown foods.

There is, of course, no uniform answer to this question, and, often, what would be a sound recommendation for one farm would be bad advice for another. The problem involves consideration of the type of livestock to which the foods are to be fed, for some will turn a given amount of feeding-stuffs into animal products more efficiently, in both the physical and economic sense, than will others. It also raises the question of which kinds of food are most economically grown—grass, corn, or roots, etc.—and of the sale crops which must be sacrificed to them. Some livestock can be kept cheaply on the by-products of arable farming ; or kept on leys, the main purpose of which is to maintain soil fertility. The rations fed to such stock may not be ideal from the point of view of liveweight increase per unit of dry matter consumed, but it may nevertheless be the cheapest way of producing meat and maintaining soil fertility.

Another facet of the problem is the difficulty, experienced by the man who relies on home-grown foods, of providing enough protein for the stock. By examining the foods consumed by dairy cows in those herds participating in the National Investigation into the Economics of Milk Production, Dixey shows that the war-time (1944-45) and pre-war (1938-39) ratio of starch equivalent to dry matter remained almost constant at about 1:1.85, but the ratio of digestible crude protein to dry matter widened from 1:6.52 to 1:8.45.

" If there is any lesson in these figures, it is that the foods the farmer grows are liable to be ill-balanced and too little concentrated".* Some classes of stock, especially dairy cows, need a higher proportion of protein to starch in their ration than do others ; but the importance of producing sufficient protein, cheaply and on the farm, is great enough to warrant an examination of its costs of production, whatever stock may consume it.

In recent years, some attention has been directed to the costs of producing home-grown foods at several of the Provincial Agricultural Economics centres ; these specific studies are amplified by the costs of growing foods used in dairy farming, which have been collected in the national investigation into milk costs. By applying the standard food values to these costs, the relative cost of growing protein in the various home-grown foods can be estimated, and from that figure, the acreage required to grow a given quantity of protein. In the tables, this information, which at present appears in various provincial publications, has been amalgamated ; the following article discusses some of the lessons they teach, as well as the limitations to their uses.

Variations from Farm to Farm Reports of growing one or more home-grown crops were issued for the years 1949 or 1950 by various centres including Bristol I and II, Newcastle, Manchester, Leeds, the North of Scotland, and the West of Scotland. These have been studied, as well as the 1949 crop costs, for each centre in England and Wales, as submitted under the national investigation into milk costs. The first point they emphasize is the considerable variation which occurs in the cost of production of the same crop in different parts of the country (Table 1).

*The Economics of Grass Conservation. R. N. DIXEY. *J. Proc. agric. Econ. Soc.*, 1949, 8, 139.

Table 1

Highest, Lowest, and Normal Cost per Acre of Growing Certain Home-Grown Foods

	Cost per Ton			Normal Yield	Percentage Protein
	Highest	Lowest	Normal		
	£ s. d.	£ s. d.	£ s. d.	cwt.	
Oats	19 3 4	10 6 0	12 10 0	20	7.6
Oat straw ..	3 12 6	1 16 0	2 10 0	18	0.9
Beans	37 6 0	13 1 8	22 0 0	14	20.0
Swedes ..	5 6 0	1 13 4	2 10 0	225	0.7
Mangolds ..	2 6 0	1 6 0	1 15 0	465	0.4
Kale	2 4 0	1 7 0	1 15 0	295	1.3
Cabbage ..	6 6 0	1 16 0	2 10 0	380	0.9
Seeds hay ..	7 1 1	3 15 0	4 15 0	30	4.9
Meadow hay	5 11 0	4 4 0	5 0 0	24	4.6
Dried grass*	—	—	27 5 0	48.3	—
Grass silage ..	3 13 0	1 6 0	2 0 0	90	2.3
Arable silage ..	3 12 0	1 16 0	2 15 0	130	1.9

* Based on—Grass Drying in 1950. C. W. Roberts. West of Scotland Agricultural College

To some extent, these variations can be attributed to changes in the weather and other conditions as represented by the two years studied, 1949 and 1950. And since no official coordination in the method of costing was adopted at the centres where the information was collected, some individuality in method may have affected the results. The influence which these two factors may have exerted is reflected by a study on the costs of growing oats, which was conducted in two districts of Yorkshire, during 1946 and 1947, by the University of Leeds. The districts were selected to contrast with one another. One sample of costs was drawn from the Yorkshire Wolds, to represent costs on comparatively large farms growing oats as much for sale as for feeding at home. The other was taken from a milk-producing district of small farms in the West Riding, where oats are grown almost solely for feeding to stock (Table 2). In each year, the costs from both the East and West Ridings were collected by the same investigator, but the 1947 records were not collected by the man who had collected the 1946 records. The differences are sufficiently great to indicate the importance of both season and district on costs of production. (The apparent discrepancy in the costs, per acre and per cwt., is explained by the method of charging only six-sevenths of the total costs to grain, and one-seventh to the straw.)

Table 2

Costs of Growing Oats in 1946 and 1947 in Two Districts of Yorkshire

	1946		1947	
	Wolds	West Riding	Wolds	West Riding
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Cost per acre	11 15 2	12 15 6	10 17 7	12 5 11
Cost per cwt. ..	9 6	12 5	10 7	12 11
Yield per acre (cwt.) ..	21.3	17.6	17.6	16.3

Even so, the difference between the highest and the lowest cost per ton may seem unbelievable without proof. Limitations of space make it impossible to consider the reasons for the range on more than one crop, and oats have been selected as an example. Details are given of the average costs per acre at the two centres with the highest and lowest costs per ton.

Bristol II (counties of Cornwall, Devon and Dorset) averaged 19s. 2d. per cwt. for oats in 1950 ; Newcastle (the four northern counties) averaged 10s. 3d. per cwt. in 1949 (Table 3).

Nearly all items of cost, per acre, were rather higher in the south-west than in the north, with a total difference of £5 8s. When to this difference is added a disadvantage of 5½ cwt. per acre in the yield, the cost per cwt. in the south-west becomes almost twice as great as in the north. But even this difference is small compared with the range in the individual farms of which each group was composed. Table 3 emphasizes how necessary it is, when comparing the costs of production of different crops, to pay attention to the special conditions of each district and, indeed, to those of the individual farms within the district.

Table 3

Oats—Details of Costs per Acre for High-Cost and Low-Cost Districts, 1949 and 1950

Direct Costs	High-Cost (Bristol II, 1950)	Low-Cost (Newcastle, 1949)
	£ *s.* *d.*	£ *s.* *d.*
Labour : Manual	3 17 0	3 3 0
Horse	4 2	3 0
Tractor	2 7 8	1 4 0
Contract	1 7 5	17 0
	7 16 3	5 7 0
Seed	2 10 6	2 6 0
Artificial manures	1 8 0	13 0
Farmyard manure	—	1 0
Rent	1 14 0	1 2 0
Miscellaneous	19 10	7 0
Machinery depreciation	1 8 6	19 0
Field upkeep	15 3	4 0
Overheads	10 10	10 0
	17 3 2	11 9 0
Manurial residues	12 10	19 0
Total	**17 16 0**	**12 8 0**
Yield per acre	15½ cwt.	21 cwt.
Cost per cwt. (average)	19s. 2d.	10s. 3d.
Range : Lowest	12s. 6d.	7s. 1d.
Highest	£2 16s. 0d.	19s. 9d.
No. of costs	11	39

With such wide variations, there is, on one hand, no point in seeking an average cost which is mathematically correct for any year or for any group or region. On the other hand, the width of the range between the highest and lowest costs does no justice to the large proportion which cluster around the modal average. Thus, ten out of sixteen sets of costs reported oats between 11s. and 14s. per cwt., nine out of sixteen swede costs were between £2 and £3 a ton, and nine out of fourteen costs for seeds hay were between £4 and £5.

It seems reasonable, therefore, to adopt a "normal" cost to be used in comparing the costs of producing the protein which nutrition chemists have found to be present in the different home-grown foods. The "normal" costs,

which appear in Table 1, are not reached as a result of applying any mathematical formula, but are costs which one could expect to be representative of most conditions in 1951, as shown by the published information for 1949 and 1950. Except for silage and grass, the protein equivalent is based on tables published by the University of Leeds and Yorkshire Council for Agricultural Education (Report No. 156b, 1936). The special values of protein in those two foods are better represented by the figures for digestible crude protein, these being used in preference to the figures for protein equivalent.

Consideration of the Crop Table 4 shows the highest, lowest, and normal cost of 1 cwt. of protein equivalent (or digestible crude protein) for each of the thirteen foods for which costs are available. The cost of protein in grass and grass silage is obviously lower than in white corn, but beans provide protein about as cheaply as silage. Roots, except kale, are highest of all. No allowance is made, however, for the cleaning value of a crop of roots. Not every farmer will admit that he needs to grow roots to clean his land ; if he does not, roots seem to be an expensive way of producing stock feed. Kale is an exception, for the protein in it is produced very cheaply ; it would, doubtless, be more widely grown if it were not such an unpleasant crop to harvest, and the marrowstem variety could be relied on after Christmas.

Table 4

Costs of Producing Protein and Starch Equivalent in Certain Home-Grown Foods

	Cost of 1 cwt. Protein			Normal Acreage to Produce		Cost of 1 cwt.S.E. (Normal)
	Highest	Lowest	Normal	1 cwt. Protein	1 cwt. S.E.	
	£ s. d.	£ s. d.	£ s. d.	*acres*	*acres*	£ s. d.
Oats	12 11 3	6 15 6	8 4 5	0.59	0.066	1 0 10
Oat straw ..	16 18 0	10 0 0	13 17 9	*	*	14 8
Beans ..	9 6 6	3 5 5	5 10 0	0.36	0.108	1 13 4
Swedes ..	37 17 2	11 18 1	17 17 2	0.63	0.063	1 15 8
Mangolds ..	28 15 0	16 5 0	21 17 6	0.53	0.028	1 3 4
Kale	8 9 3	5 15 4	6 14 8	0.26	0.038	19 10
Cabbage ..	48 17 9	10 0 0	13 17 9	0.29	0.037	1 15 8
Seeds hay ..	7 4 0	3 16 6	4 17 0	0.68	0.139	19 9
Meadow hay	6 0 8	4 11 3	5 8 8	0.90	0.134	16 1
Dried grass† ..			10 4 0	0.16		
Grass silage ..	7 18 8	2 16 6	4 7 0	0.48	0.117	1 1 0
Arable silage	9 9 5	4 14 9	7 4 9	0.40	0.067	1 3 11
Temporary grass			1 4 2‡	0.24‡		
Permanent grass			1 7 11‡	0.46‡		

* included in Oats.

† Based on—Grass Drying in 1950. C. W. Roberts. West of Scotland Agricultural College.

‡ Based on—Costs of Production of Cereals, Roots and Forage Crops on Welsh Farms in 1942. W. J. Thomas.

An advantage of leys, not allowed for in the costs, is their value in improving the organic content of the soil ; in this, they compare favourably with the exhausting effect which corn has on the soil.

The relative production costs of protein in different foods is only one way of judging their suitability. The acreage of land devoted to growing stock

feed could usually be growing some other crop which, if sold, would bring in a profit. Consequently, it is important not only to grow protein cheaply, but also to devote as little land as possible to the crops which supply it. Table 4 shows that, in providing 1 cwt. of protein, normal yields of kale and cabbage require only about one-half the acreage needed by white corn, swedes and mangolds. Temporary grass, grazed throughout the year, similarly produces a large amount of protein per acre. Hay contributes comparatively little, but it must be remembered that the land is given up to the hay crop for only a small part of the year ; for the rest, it provides grazing. Beans have been an unpredictable crop in recent years, but, at a yield of 14 cwt. per acre, they require scarcely more land than do kale and cabbages to provide 1 cwt. of protein, and much less than most other crops.

In comparing the suitability of the different crops, it must not be forgotten that some stock require a more proteinous ration than others, and all require more starch than protein. It would be wrong, therefore, to judge home-grown foods entirely by their protein content, and to pay no attention to the quantities of starch. Table 4 shows that white corn and mangolds and kale produce 1 cwt. of S.E. at a cost that is reasonably low, but that in swedes and cabbage is higher. But if it is allowed that one of the big problems of mixed farming today is to produce enough protein for the stock, then the difference in the value of starch, food by food, is comparatively unimportant.

It remains to consider the relative advantages of feeding home-grown protein and available purchased protein. This comparison is made difficult because of the near impossibility of buying straight cakes, and the unpredictable composition of compounds. The small amount of linseed cake, fed by farmers co-operating in the milk costs scheme in August, cost £1 10s. 3d. per cwt., or £6 1s. per 1 cwt. protein. Compounds were dearer than this, and some are now approaching £1 18s. or £2. Generally, the protein in them would, therefore, cost considerably more than £6 per cwt., and would seem expensive compared with beans, grass and grass products, but probably no dearer than white corn, and cheap compared with roots. The main feature to consider, however, is that, by feeding purchased cakes, land which might otherwise be growing fodder crops is released for cash crops, and, provided the profit on these is no less than the difference between the cost of purchased and home-grown protein, it must pay to take up whatever coupons are permitted. The real difficulty is to decide between cash crops and food for stock, and between the different ways of producing the stock feed. This article shows the impossibility of laying down a set of rules suitable for all circumstances ; but even so, it indicates some of the main factors which will influence the individual farmer's decision. Further, the range in costs emphasizes the possibilities of cheapening the keep of animals by economies in the cost of producing home-grown foods and the importance of increasing, where possible, the yields per acre.

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A summary of a series of four discussions broadcast in the B.B.C. Home Service

1. Kenneth Russell and T. S. Bennett **December 13, 1951**

THE dairy cow as consumer was the focal point of the first discussion in this series between Mr. Kenneth Russell, of the Royal Agricultural College, Cirencester, and Mr. T. S. Bennett who farms very successfully 820 acres at Lower Wick and Madresfield, in Worcestershire. Reduced subsidies on feedingstuffs and fertilizers have meant higher cost of production to the farmer, and it follows therefore that when a farmer has grown the most suitable crops of which his land is capable, they should be fed with precision to secure the highest possible return. Mr. Bennett favours dried grass but, as Mr. Russell pointed out, the high capital cost of installing driers puts this product out of reach of most of the smaller farmers ; 80 per cent of our farms are under 100 acres and the average sized dairy herd is only about fifteen cows. Against this, however, Mr. Bennett thought that communal grass drying (which has financial assistance from the Government) would afford the small man an excellent opportunity of increasing his production with fewer concentrates.

But grass drying is only one way of saving purchased concentrates : arable land can provide a wide variety of crops, including arable silage, dredge corn, and there is also hay and grass silage. " Would you not agree," asked Mr. Russell, " that mixed farming is a better asset to the nation as a whole ? " Mr. Bennett doubted whether the mixed farm can produce more per acre than the specialist—and increased production per acre is what the nation needs. At Lower Wick, Mr. Bennett keeps one cow to one and a third acres and produces therefrom 500 gallons of milk per acre per year ; over the past sixteen years he has, in addition, dried over 400 tons of grass at an average of 55 cwt. of dried grass per acre cut.

Russell : " But surely the man who's the greatest asset to the nation is one who keeps the plough going . . . Our main feeding problem is to bridge the winter gap. My contention is you can best do this with the products of a mixed farming economy such as home-grown cereals and beet pulp, by catch crops, by grazing kale, and by conserving grass cheaply."

Mr. Bennett explained that he was thinking in terms of well-managed first-class permanent pasture—not leys ; and, as Mr. Russell admitted, Mr. Bennett's permanent pasture is " superb stuff". By regarding permanent grass as more of a crop, continued Mr. Bennett, giving it better management and balanced fertilizing in spring and summer, and paying more attention to conservation, this kind of system could be generally extended to help with milk production.

Looking at the problem from the specific point of view of milk production, Mr. Russell gave it as his opinion that if we want to maintain production—let alone increase it—with fewer rather than more cows, it means feeding the high yielding cow—and the high yielding cow must have high quality food. The low yielding cow is robbing her more valuable neighbour. " There is no justification whatever, in my opinion," he said, " for feeding any concentrates to the lower yielding cow, and by that I mean the cow that never exceeds three gallons at her peak—the average six hundred gallon cow—more particularly if she is a spring calver."

Mr. Bennett entirely agreed and said that the only concentrates he uses go to his best yielders. But why tolerate the six hundred galloner ? At Lower Wick, his herd of a hundred pedigree Ayrshires averages just on 1,000 gallons ; and of that over 700 gallons are produced from grass and dried grass grown on the farm. The high yielding cow is by far the most efficient animal on the farm to turn imported feedingstuffs into human food, said Mr. Russell, and has, therefore, a stronger claim to them than either the pig or the hen, which are its chief competitors. " I don't think it means that the good dairy cow must necessarily suffer through the reduction in imported concentrates " he said. " It could easily be got over by eliminating all the poor cows. But you've got to back up your good cows with good management and good farming."

The feeding programme at Lower Wick makes no provision for hay. Three cuts are taken from permanent pasture for drying : the first in April and May, returning a crude protein content of 16–20 per cent, is fed at the rate of 5 lb. per gallon ; the second, taken in June and July, has a lower protein content and therefore used exclusively for maintenance of the younger stock ; the third cut, in August to October, produces 13–17 per cent crude protein and is fed for maintenance and the first two gallons.

At Cirencester, Mr. Russell makes silage from May grass only, by the buckrake and pit method. The crude protein figure works out usually about 14 per cent, and this he has found excellent for maintenance and the first gallon and a half of milk. But he also feeds about 8 lb. of good hay per cow per day. Re-emphasizing that dried grass is not a small farm product, Mr. Russell pointed out that we now have the machines to make hay without drawing heavily on labour, and we must now learn how to use them wisely, so making good hay (7–8 per cent protein) at low cost. To Mr. Russell's renewed plea for leys as against permanent grass, Mr. Bennett said he had evidence of infertility where increased production, is achieved by intensive feeding of concentrates and ley farming is practised extensively. Overfeeding of protein, and underfeeding of minerals and trace elements from unbalanced ley pastures lead to sterility problems. There is no such trouble at Lower Wick, where the calving index is on average 372 days.

" We can still go on producing milk with fewer concentrates," remarked Mr. Bennett, " provided we feed the little we have correctly and that we aim at becoming more and more self-supporting in one way or the other. After all, grass is the basis of economic milk production, and the problem we have to solve is one largely of producing it and then either grazing or conserving it efficiently by improved methods."

" But because we want cheap methods of conservation, I believe silage and hay are important," added Mr. Russell. " What you are doing with your dried grass, Bennett, the rest of us must do with our hay, silage, root crops and so on, varying the quality of the home-grown foods fed to fit the needs of the cow according to her level of production, as you do Bennett with your different grades of dried grass."

2. W. A. Stewart and Alan H. B. Grant **December 20, 1951**

ECONOMIC beef production is a pre-natal consideration. In other words, as expressed by Mr. Grant, good breeding is every bit as important as correct feeding and sound management. An animal that hasn't the natural tendencies to lay on the maximum amount of flesh in the right places on the minimum amount of foods, he said, can never be anything but costly to rear, especially as far as concentrates are concerned ; you must have animals bred from beef-type cows and sired by a good, fleshy, beef-type bull.

On Mr. Grant's farm at Thorn, Blairgowrie, Perth, all calves (blue-grey or crossbred sired by an Aberdeen-Angus bull) are weaned in the autumn, then continued in yards. The best diet for calves, in Mr. Grant's opinion, is thinly sliced yellow turnips for a start and then swedes in the latter part of the winter, along with a supply of good oat straw fed *ad lib*. They should also be given good hay once a day (more often if it can be spared, in place of straw) plus a mash of good bread bran and crushed oats with a little treacle—and some fishmeal if it can be managed. Failing bran, oat feed can be used, although it is not so good. All Mr. Grant's young stock are reared singly whereas, as Mr. Stewart, Principal of the Northamptonshire Institute of Agriculture, Moulton, pointed out, the Midlands practice is multiple-suckling, which incurs a heavier demand on concentrates. He cited trials on the Cambridge University Farm where multiple-suckled calves, on what is called the " high plane," have been getting up to 6 lb. concentrates and up to 7 lb. hay a day by the time they were eight months old. Those on the "moderate plane" got 40 gallons of milk apiece, up to 2½ lb. of calf mixture and 5 lb. of hay. The cost of feed for those on the " high plane " at eight months, was over £20, but for the " moderate plane" lot, about £10 apiece.

Mr. Grant agreed that the " high plane " feeding was too generous of concentrates, but the " moderate plane," he thought, would be the best alternative to his own system of one calf per cow.

At Moulton, the practice is to feed 80–100 gallons of milk by way of multiple suckling and up to 3 lb. concentrates, with hay and greenstuff in season. The cows rear three to five calves apiece, and they manage on grass and bulky foods with little or no concentrates.

Mr. Grant admitted that it might be possible to rear more calves a year by this method but not any cheaper than he can by his, and certainly not on as few concentrates or with as little labour.

Stewart : " Maybe you're right. The figures published by the Agricultural Economist at Newcastle show that in Northumberland crossbred, singly-suckled calves cost £19 odd to rear to weaning, and Galloway calves round about £18, so it does seem that with higher costs of feedingstuffs and higher costs of labour single-suckling may be a proposition. In any case it saves concentrates. But tell me how you carry on your young cattle from their first spring, and about your Smithfield winners. How far can you go on reducing concentrates for them ? "

Grant : " Well, the calves come out of the yard in the spring and are grazed all summer on good grass and taken into the courts again in the autumn. They are then drawn into separate lots : those that are likely to be fattened in the winter, and the smaller ones that are not. They all get turnips and good straw—as much as they can eat to start with. After the new year a start is usually made to give something extra to those that are to be graded out of the courts in the late spring. This is usually done in the form of a little hay once a day—preferably given in the evening—and is gradually increased as the time goes on. About a couple of months before they are due to be sold they should get 4 or 5 lb. of crushed oats per day as well. Those that are not to be sold fat in the spring, but are to be graded off grass in the following autumn, are, of course, kept only on turnips and straw all the time. All these cattle, I should also mention, should be getting 70–90 lb. of sliced swedes per day and should, of course, be fed regularly and kept dry-bedded."

The Smithfield cattle, he said, are fed in the same way, and the only concentrates they have are oats and bran mashes with a little boiled barley added to it. They get no oil cake of any description ; it all goes to the dairy side.

In the absence of turnips, swedes and oat straw, as good as those which Mr. Grant can provide for his stock, Mr. Stewart pointed to the value of kale, fodder beet, lucerne, silage, and good green hay. He particularly emphasized the value of well-made hay, since in these days of silage, dried grass and pick-up balers, many people are inclined to overlook just how valuable good hay can be. Kale, too, is a useful protein crop, particularly at the back-end, and more could be done with it, he thought, on the drier land by strip-grazing controlled by electric fencing. Fodder beet, with a yield at Moulton last year of 23 tons to the acre (30 tons in 1950), and over 20 per cent dry matter and 15 per cent sugar, is an attractive crop : 5–6 lb. of it will replace 1 lb. of concentrates or 10 lb. of turnips or other roots.

Mr. Grant hasn't had any experience of silage, but he strongly supported the claim for hay ; it is probably the best feedingstuff we can grow, he said, provided it comes from *good* grass, is cut at the right time and is secured in good sunny weather.

Turning to sheep, the speakers agreed that the concentrates problem is much simpler : they don't need much at all. " If we confine ourselves purely to winter fattening," remarked Mr. Grant, " I think the best method is to put about 300 to 350 in one lot, and after cleaning up all the foggage and aftermath, put them on to yellow turnips on the face. These should be stripped—in other words, every second day's drills pulled and pitted elsewhere, and the sheep folded on the remainder, a fresh break being given each day. It's also advisable to give hay—as much as they can eat—in order to prevent deaths from eating frosty turnips. Cut swedes can follow in the new year. They should eat 15–16 lb. a day and at this stage you should also start giving them ¼–½ lb. of crushed oats a day, together with their hay. By this method the sheep should be fat and ready to grade at good weights by the middle of March, or even earlier, and I don't think one can feed sheep economically on less concentrates than that."

" Unless it's on beet tops and hay," rejoined Mr. Stewart.

3. M. B. Watt and J. D. F. Green **January 3, 1952**

SAVING concentrates in pig feeding is a more difficult problem. Mr. Watt, who for the past three years has been carrying Essex sows crossed with a Large White boar on light land at Orsett, on the edge of the Tilbury Marshes, bases his system of feeding on the controlled grazing of young lucerne leys from April to October and, for older pigs, on the use of fodder beet. Contrary to Mr. Green's fears, the lucerne leys suffer no damage by rooting if the pigs are bull-ringed at about six months old. The plan is to stock heavily, graze down quickly and move on to the next paddock. Good shelter is important if food isn't to be wasted, and on Mr. Watt's farm the stores, which are out from weaning until 3½ months old, are housed in triangular arks which are towed from one paddock to the next.

But Mr. Green, the Gloucestershire Old Spot breeder of Chedworth, Glos, was not entirely impressed with the merits of this system. " I sometimes think," he said, " that you save food if you keep pigs in right from weaning. This is certainly true on high, exposed land. But how do you solve watering and labour problems ? "

The answer was : labour attention only once a day, with automatic feeding and watering. To Mr. Green's objection that automatic feeding is

again likely to waste food, Mr. Watt replied that that hadn't been his experience whilst store pigs are grazing lucerne ; they take no more out of the automatic feeder than if they are trough-fed up to 3½ months old. Freezing of the water-bowls has, of course, to be watched, and he did not deny that in some other, more rigorous, areas it might be better to put stores into yards, where there is warmth and more protection. But some provision for exercise in the store period should be made, since it is better to put weight on to a long frame than a short one.

Speaking about the other side of his feeding programme, the use of fodder beet, Mr. Watt said : " We've only started using it this winter and, as I said previously, we feed our dry sows in the winter a high protein meal of 3 lb. and then 15 lb. of fodder beet. The baconers get 3 lb. of meal and fodder beet at the equivalent of 6 lb. of fodder beet to 1 lb. of barley meal." This is a considerable saving—approximately one-third of the meal in the bacon stage.

" Have you any tips about growing it ? " asked Mr. Green, who has not tried it.

Watt : " I should say that every farmer who keeps pigs should consider putting in at least a couple of acres of fodder beet this coming spring. If they have equipment for lifting and handling sugar beet already, I would suggest they grow Hunsballe Rex, which has the highest dry matter content—about 20 per cent. But if they haven't that equipment, don't go out and buy it and don't grow Hunsballe, grow Pajbjerg Rex, which lifts like mangolds, by hand, and there is no dirt problem. . . . Pajbjerg Rex has slightly less dry matter content, but you can handle it all with your own labour . . . When I said grow a couple of acres, I really wanted to make the point that it is far better to grow two acres well than four acres just medium, especially as far as roots are concerned. I'd say dung it well, twenty loads to the acre, fertilize it, say 10 cwt. of the normal root compound, and then you will grow as much on two acres as you would on four normally done." The cost would work out at about £50–60 an acre, but, Mr. Watt hastened to add, " you will grow probably about 30 tons to the acre if you do it well, which is equal to 5 tons of barley per acre . . . and that means that your barley is costing you £12 per ton."

Mr. Watt asked Mr. Green what was his recipe for maintaining our present pig population when, as he believed, we have enough purchased concentrates for only three-quarters of them.

Green : " I think the important thing is to save waste, not to treat the sow as something that hangs round behind the buildings, but treat her as we do our cows. Remember the best food for a pig is the sow's milk. So first of all I say steam up your sows and get as much milk as you can. The next thing is creep feed as early as you can, so that you get a good weaning weight. If necessary, wean later. Don't be too greedy and try and get too big a turnover, but get *good pigs*."

Mr. Watt had no quarrel with the first two points, but he could not agree with later weaning. " If we're going to get our weaners up to 45 lb. at eight weeks, what is the sense of keeping them on the sow ? They'll only put her down farther, and it'll also stop you getting two litters a year."

Green : " Well, I couldn't agree with you more, *if* you get your pigs off at 45 lb. at eight weeks. But what farm average *is* 45 lb. at eight weeks ? "

Watt : " It can be done provided you feed your sow properly before farrowing, that is with a high protein feed, to see that the milk's there ready, and that you creep feed from three weeks old . . . I say you should get your

litter off at 380 to 400 lb. at eight weeks. Remember that every extra pound that you get your weaners up to at eight weeks means two and a half to three days shorter fattening period."

That is true enough, admitted Mr. Green, and it is a safer guide to take not the number of pigs but the total weight of the litter.

Mr. Watt summarized his methods of saving concentrates in pig feeding under six heads : (1) It's a waste of time feeding food to pigs at all unless they're warm and dry during the whole of their existence. (2) You must get the best milking strain within the particular breed you keep, that is a strain bred to produce more milk and make the weaners a higher weight at eight weeks. (3) We must see that we provide adequate protein ; and I can't over-emphasize the importance of adequate protein to the in-pig sows and the sucklers with the creep feeding. (4) We can save food by controlled grazing of our lucerne or perhaps clovers ; as a matter of fact, our farrowing pens are on clover this year. (5) We can save food again with fodder beet for baconers and the dry sows in winter, remembering, of course, to add that extra protein when they're on the fodder beet. (6) The whole system is intended to save labour (that is most important) and call for a low capital investment in buildings."

Mr. Green thought that Mr. Watt's plan was good if it could save labour and end unnecessary expense in building and other capital outlay, but he thought farmers on heavy land, or in high places, would have to modify the scheme to suit their special conditions.

4. W. A. Crawford and Alan Thompson **January 10, 1952**

BOTH Mr. Crawford, who farms near Thetford, in Norfolk, and Mr. Thompson, of Warminster, Wilts, got off to an agreed start that under modern farming conditions and its emphasis on the ley, it is to the general farmer that we must look for increased egg production. Mr. Crawford's own system provides for housing his layers in solid floor houses, made up in sections so that they can be moved round the farm, and they are put on to leys which are first run over by sheep and cattle to keep them in first-class condition for poultry grazing. The houses at present in use are 24 feet × 12 feet, but to anyone laying down a new unit Mr. Crawford would recommend houses half that size (say, 15 feet × 10 feet) on skids. Under these conditions he is satisfied that the farmer can get a high enough proportion of winter eggs with good health and good breeding to make that the best way of egg production on the general farm with home-produced foods.

" I am just wondering, though, whether you're going to get your 70 per cent production in the winter from solid-floored mobile houses " said Mr. Thompson.

Mr. Crawford replied that he was satisfied with 60 per cent during the two winter months, an all-round-the-year production and eggs in the second winter.

Thompson : " The second winter ! You keep them for two years ? "

Crawford : " Yes, or at any rate until the price for the hens becomes worth while . . . I always find that it pays to carry the birds through the second winter, with the number of eggs they were capable of laying plus the manure, plus the added price through keeping them."

Mr. Thompson could not accept this easily. The birds must pay on their own, without hidden advantages to the rest of the farm. " I maintain," he said, " that you could kill your birds after only six months' lay after

their winter production, in March and April and still get 3s. a lb. The Government, by their price emphasis, are rather forcing us to do that." But Mr. Crawford then wanted to know where the eggs were coming from in June to September ; to which Mr. Thompson replied that if the Government wanted summer eggs they must pay adequately for them.

The discussion turned to earlier hatching, and Mr. Crawford agreed with Mr. Thompson that it would be a very good thing if farmers hatched their chicks in January or February, as well as in March and April, and slowed down the maturing of early pullets by ley feeding and grain. The later birds could be brought along normally.

Mr. Crawford's system is to feed chicks up to twelve weeks old with a ready-mixed mash plus grain. From then, until the pullets come into lay at about six months, they are out on grass and grain (chiefly oats—and *whole* oats at that ; although against all the rules, Mr. Crawford claims that it works). The birds are fed on the ground, out of a bag—7,000 in half to one hour. He feeds no bought minerals, only an abundance of gravel pit screenings, which also provide flint grit and silica.

Winter layers' rations consist of half bought mash (including cod liver oil) and half home-produced consisting of dredge corn, ground wheat, barley meal, wheatings, maize meal, linseed, fishmeal, protein concentrates and minerals. Farm grinding and mixing isn't a big job, said Mr. Crawford. He has a hammer mill and a food mixer, and corn is on the spot ; grinding is just a job for wet days. The linseed is merely rolled and put through the mash mixer with the other ingredients.

In March, feeding is modified to give about half the protein, reducing to an almost negligible supply by the end of March or soon after. The protein is in the leys, which are made up of Kentish ryegrass, and wild white clover, undersown in the corn, and grazed heavily from harvest to Christmas or thereabouts. They are then dressed with slag and potash, and rested until early February, when grazing starts again. Liming is done as soon as the land will carry spreaders. The soil is medium clay which is able to stand up fairly well to drought, and we try to produce the utmost possible from these leys in the way of grass for cattle, horses, sheep and poultry. They also provide silage and hay for the cattle, horses and sheep in winter.

Thompson : " Good. I particularly like your emphasis on heavy grazing. I'm sure it makes a palatable sward free from parasites."

Crawford : " It's vital."

Mr. Thompson was then interested to know about costs. Mr. Crawford's ration costs something like £35 a ton, which means that each pullet must produce roughly two eggs a week to pay for the food. Grass provides the protein in spring and summer, so he reserves his early protein coupons for the autumn and winter.

In Mr. Thompson's experience, however, grass, because of its fibre content, is not an important factor in egg production, and he thought, too, that Mr. Crawford's birds would be better housed and serviced in the winter if they were brought into a protected compound near the farm buildings ; electric light is essential for winter eggs. But Mr. Crawford was not shaken.

" Where you have normal shelter," he said, " I still think that the birds are better taken to the grass to help themselves than being given dry grass out of a bag. Rather give them a comfortable, dry, airy house with access to grass to balance any deficiencies in feeding."

Thompson : " Well, I wouldn't put too much grass in the bag at all. Hens have too much fibre as it is, and poultrywomen too much walking."

Crawford: " Then you must grow grass that's not full of fibre. Keep it grazed."

THE INFLUENCE OF NITROGEN ON THE YIELD OF SPRING WHEAT

T. W. WALKER, B.Sc., Ph.D.* and D. H. ROBINSON, B.Sc., Ph.D., N.D.A.

National Agricultural Advisory Service, West Midland Province

Trials conducted in the Midlands in 1948-50 indicate that under normal soil conditions and with reasonable standards of husbandry, the application of nitrogen to the seedbed will result in considerably increased yields of spring wheat without adding unduly to the danger of lodging.

THE importance of nitrogenous top dressings on *winter* wheat has been well established for a number of years, but much less is known about the effect of nitrogen on *spring* wheat. To obtain information on the point, the Field Experiments Committee of the West Midland Province began in 1948 a series of trials to test the effects of increasing amounts of nitrogen applied as sulphate of ammonia to the seedbed (not as a top dressing). A total of fifteen experiments has now been conducted over a period of three years, and a summary of the results will therefore be of interest.

The treatments consisted, in nearly all cases, of applying sulphate of ammonia to the seedbed at sowing time, at 1, 2, and 3 cwt. per acre. In each case there were four replicates, and the crop was harvested by combine. No base dressings of phosphate or potash were given, although in at least one case phosphate deficiency may have been a limiting factor. Weeds were also a serious factor in reducing yields in two experiments. The results therefore tend to under-estimate the responses that would be obtained under the best farming conditions, but they do indicate what can be achieved by the use of nitrogen alone.

The reasons for deciding to apply the nitrogen in the seedbed were that by insisting upon the distribution of the fertilizer before drilling, it was thought that greater uniformity would be achieved than if application were made as a top dressing and, secondly, that the nitrogen would be available at once to the seedling and might therefore be expected to have maximum effect. (The experiments to be described do not, of course, prove this, and further trials are required to find out if there is in fact a difference between top dressings and seedbed applications.) There is also the point that while in practice a farmer may have every intention of top-dressing a crop at a certain stage of its development, unsuitable conditions or even forgetfulness may result in the work never being carried out. If the nitrogen is put into the seedbed—the normal method of applying fertilizers—the job is done and can be forgotten.

In these trials the nitrogen was, with only one or two exceptions, added in the seedbed. Usually the sulphate of ammonia was put on before drilling, but in some cases the seed was drilled and the fertilizer scattered on top of the drill marks in order to save marking out the strips with string : subsequent harrowing covered both grain and fertilizer. In the 1950 trial at Hinton, a top dressing of sulphate of ammonia was given several weeks after planting, but this trial was unconvincing in many ways since no farmer would normally have applied extra nitrogen because of the forward nature of the crop, and the trial was carried on only because no alternative site could be found.

*Dr. Walker has recently taken up an appointment as Professor of Agriculture (Soil Science), Canterbury College, University of New Zealand.

INFLUENCE OF NITROGEN ON THE YIELD OF SPRING WHEAT

Favourable Responses The following table summarizes the results obtained during the three years in which the trials were conducted.

Summary of Results 1948-50
(Yields in cwt. per acre)

Centre	*Variety*	Rate of Application of Sulphate of Ammonia in cwt. per acre				*Mean*	*Standard Error*
		0	*1*	*2*	*3*		
1948							
Spetchley (Worcs)	Atle	20.8	23.2	24.3	24.1	23.1	± 0.43
Mamble (Worcs)	Fylgia	31.8	34.9	34.9	37.0	34.6	± 0.68
Seighford (Staffs)	Fylgia	27.3	27.2	28.1	30.3	28.2	± 0.46
Seighford (Staffs)	Atle	29.0	29.3	29.8	29.2	29.3	± 0.66
Dodwell (Warwicks)	Atle	21.1	25.4	27.9	31.5	26.5	± 0.56
Presteigne (Hereford)	Atle	32.1	39.0	37.4	39.1	36.9	± 1.84
Mean Yield — All Centres		26.8	30.1	30.5	32.3	29.9	
1949							
Peterchurch (Hereford)	Atle	27.5	31.4	33.2	34.3	31.6	± 0.90
Lower Lyde (Hereford)	Atle	19.6	21.9	22.7	23.6	22.0	± 0.26
Rushford (Warwicks)	Bersée	28.5	30.7	31.8	31.3	30.6	± 0.54
U. Snodsbury (Worcs)	Atle	13.1	15.4	16.9	17.5	15.7	± 0.36
Mean Yield — All Centres		22.2	24.8	26.1	26.7	22.5	
1950							
Rosemaund (Hereford)	Atle	18.9	22.0	23.4	25.2	22.4	± 0.29
	Fylgia	17.9	17.5	16.8	17.3	17.4	
Dodwell (Warwicks)	Atle	21.8	24.2	26.5	27.1	24.9	± 0.62
Rushford (Warwicks)	Atle	17.9	20.3	20.6	22.1	20.2	± 0.31
Hinton (Worcs)	Atle	33.5	31.7	30.7	32.6	32.1	
Mean Yield — All Centres		22.0	23.1	23.6	24.9	23.4	
Mean Yields — All Centres (over 3-year period)		23.7	26.0	26.7	28.0	25.3	

The results for individual centres have been given in order to show that responses have been obtained under both good and poor conditions, and on a variety of soils. For example, of the centres used in 1948, Spetchley was situated on Keuper Marl at an altitude of 200 feet, the Mamble centre on Coal Measures at about 500 feet, the Dodwell centre was on Lower Lias

Clay and Presteigne on Silurian Limestone at 650 feet. It is interesting also to note that additional nitrogen has given results on land in a high state of fertility as well as on land in a much poorer condition. At Presteigne in 1948, spring wheat followed potatoes, which had been preceded by sugar beet. The yield of the no-nitrogen plots was 32 cwt. per acre, yet the addition of 1 cwt. sulphate of ammonia increased the yield by nearly 7 cwt. per acre. At Upton Snodsbury in 1949, on poor, heavy Lias Clay, the very unsatisfactory yield of 13 cwt. per acre on the no-nitrogen plot was increased by over 2 cwt. as the result of the application of 1 cwt. sulphate of ammonia.

It is, of course, extremely difficult to forecast what effect nitrogen will have on a given soil. At three centres out of the fifteen, it gave little or no response; but then in at least one case the limitation was due to extreme phosphate deficiency, and in another, weeds caused trouble. Clearly, if any serious phosphate or potash deficiencies can be remedied by prior soil analysis, and if the canons of good husbandry are followed, there is every chance that nitrogen applied to the seedbed for spring wheat will give profitable increases in yield.

One of the most interesting features of the trials was that, despite the fact that the 1948 and 1949 seasons were wetter than usual, no lodging was caused in any of the experiments, even on the plots which received 3 cwt. per acre sulphate of ammonia ; this suggests that spring wheat, with its shorter growth season, is more resistant to lodging caused by application of nitrogen than is winter-sown wheat.

Judging from these trials, one would be on safe ground in recommending the use of at least 1 cwt. per acre sulphate of ammonia for spring-sown wheat, even without prior knowledge of the soil conditions. Although in the trials nitrogen continued to give increases in yield up to the maximum used, the responses were proportionately less for the higher dressings. From the smooth curve obtained by plotting yields against the amounts of sulphate of ammonia used, the following responses and profits are obtained :

S/A Dressing	Extra Yield of Grain	Gross Return*	Net Return*
cwt.	*cwt.*	£ *s.*	£ *s.*
1	1.9	2 13	1 8
2	3.3	4 12	2 11
3	4.3	6 0	3 4

*For the purpose of these calculations, wheat has been valued at 28s. per cwt., sulphate of ammonia at £15 3s. per ton, and spreading costs for all quantities from 1 to 3 cwt. at 10s. per acre.

At the present prices of fertilizers and wheat, there is every inducement to use 1 cwt. sulphate of ammonia per acre ; but there is a smaller margin of profit if more nitrogen is used, unless, as in some of these experiments, the second and third hundredweights give further marked increases in yield. This can be decided only by experience on individual farms, and farmers are recommended to test for themselves the higher rates of sulphate of ammonia on small areas of a given field. Local information on the risks of lodging will accumulate, and will indicate to some extent whether or not heavier applications of nitrogen would still be profitable. At Dodwell, for instance, on Lias Clay in 1948 and 1950, nitrogen gave marked responses, even for the third hundredweight of sulphate of ammonia.

From the point of view both of increased national production and individual profit, the widespread use of nitrogen as a seedbed fertilizer for spring wheat should be encouraged. If the spring wheat crop is not being undersown with seeds, the best advice that can be given is to use just as

much nitrogen as is possible without causing lodging. On fields which are deficient in phosphate or potash, these fertilizers should also be used to ensure the maximum return from the nitrogen.

The figures given in this brief report are based upon trials in which both Provincial and County officers of the N.A.A.S. took part. Special thanks are due to those farmers who allowed experiments to be carried out on their farms.

YELLOW RUST IN WHEAT

ITS SIGNIFICANCE IN WHEAT CULTIVATION AND BREEDING IN ENGLAND

G. D. H. BELL, B.Sc., Ph.D. and F. G. H. LUPTON, M.A.
Plant Breeding Institute, School of Agriculture, Cambridge

The only effective means of controlling Yellow Rust is by breeding varieties resistant to the disease. Recent seedling tests at Cambridge show how the plant breeder is grappling with the problem.

THE importance of controlling Yellow Rust (*Puccinia glumarum*) in wheat by breeding resistant varieties was first appreciated by Biffen, and as a result of his work at the Plant Breeding Institute, the hybrid variety Little Joss was marketed over forty years ago. This variety, which was bred specifically for its resistance to Yellow Rust, showed a higher degree of resistance than the varieties commonly grown at that time in this country, and even today the resistance of Little Joss is taken as a standard at which to aim. Unfortunately, few of the new varieties that have found their way into British agriculture in recent times possess a resistance to Yellow Rust equal to that of Little Joss, while some varieties even show a lowering of the standard compared with the behaviour of the older varieties bred in this country.

One of the outstanding features of post-war wheat growing has been the large number of European continental wheats which have been introduced to the farmer. Many of these varieties, the bulk of which are French, have excited considerable interest because of their valuable attributes of short, strong straw, ability to give high yields under certain conditions, and alternative habit making some of them suitable for spring or winter cultivation.

Against these obviously attractive characters there must be set, in some instances, poor or indifferent grain quality, particularly for milling, and a higher susceptibility to some diseases, amongst them Yellow Rust, than is desirable for the efficiency of wheat growing.

Foreign Wheats Unfortunately, most wheats that are imported for cultivation reach the farmer before they have been adequately tested, and therefore before there is sufficient knowledge of their true worth for British conditions. Consequently, although there is at the moment a large number of foreign wheats, especially French, being advertised and grown in this country, farmers have considerable difficulty in making their choice. There is, of course, considerable danger in a position which allows foreign varieties to find their own level in farming before adequate tests have

been conducted, if these varieties possess important defects such as susceptibility to diseases. There is little doubt that the varieties that used to dominate wheat growing in this country helped to keep the disease in check. Today some observers consider that Yellow Rust in wheat is considerably more prevalent and widespread than it used to be, and that this condition has coincided with the influx and popularity of certain foreign wheats. It appears to be true that reports of serious outbreaks of Yellow Rust are usually associated with particular foreign varieties, and there is little doubt that there would be serious danger of wheat growing in this country losing its comparative freedom from epidemics of this disease if there was a major swing to the cultivation of susceptible varieties.

The Need for Resistant Varieties

There is at the moment no effective means of controlling Yellow Rust other than by the cultivation of resistant varieties. The fungus causing the disease has airborne spores which spread the disease within the crop and from field to field during the spring and summer months if conditions are favourable. The disease first attacks the leaves of young plants and may reach serious proportions at any time from April to June, although the period between infection and the first appearance of symptoms varies with the weather. The spores germinate on the leaves, enter through the epidermal apertures (stomata), and the first yellow pustules, which later coalesce into the characteristic striped areas of infection, appear some time between ten days and three weeks after infection. Although the fungus can remain active during the period the crop is green, and may cause infection of the ear, serious outbreaks are rare after the end of June in this country because the fungus cannot tolerate high temperatures. The method by which the fungus overwinters is not completely understood, but it probably lives in a more or less dormant condition on early-sown autumn crops or volunteer plants.

Knowledge of these basic characteristics of the relationship between the fungus and the host plant is essential to a proper understanding of the problems relating to the control of the disease. As in this case the only effective means of control is the growing of resistant varieties, it is essential to understand the nature of any inherited resistance as it occurs in cultivated varieties. It has been clearly demonstrated from researches in various parts of the world that resistance and susceptibility are inherited characters, although there is no general agreement on the mode of inheritance, some workers claiming it to be of a simple Mendelian type, while others state that it is more complex. One of the reasons for this difference of opinion is undoubtedly due to the fact that the fungus exists in a number of physiological races, and varietal reaction of the disease depends on the individual relationship of each race to the variety. Thus a variety may be resistant at all stages of growth to all the races, or it may be similarly susceptible, while intermediate conditions of resistance and susceptibility to the races can exist in many varieties. There is some evidence (Dillon Weston,[1, 2] ;Manners[3]) that the six common races known in this country tend to have different areas of distribution, while it is certain that in any particular year in any one area certain races will dominate the position ; in another year or in another area, quite different races may predominate.

The desirability of knowing the reaction of individual varieties to the various rust races becomes obvious if there is any suggestion that the disease is increasing in the country because of the spread of more susceptible varieties ; also, if breeding programmes are to be based on varietal resistance, the details of this resistance must be known. Field observations of natural

infection are, of course, quite inadequate for acquiring the necessary knowledge, and consequently artificial tests were conducted at Cambridge based essentially on the rust races and techniques used by Manners(3). These tests consisted essentially of artificial inoculation of varieties with each of the known races under controlled greenhouse conditions, the plants being inoculated in the two-leaf stage and subsequently grown for two days in humidity chambers and then under transparent covers.

Such tests show an interesting condition with regard to resistance and susceptibility at different stages of growth. Thus, if the seedlings are resistant, the plants remain resistant at all later stages of development ; but if the seedlings are susceptible, this condition may persist during all subsequent stages, or, in certain varieties, the plants may acquire resistance—known as " mature plant " resistance—at a later stage.

Although comparatively little is known concerning the relative amount of damage caused by the fungus in its attacks at different stages of growth of the plant, it is obvious that resistance throughout life is the best solution of the rust problem when considering varieties. It is well known that later attacks by Yellow Rust cause shrivelled grain with loss of yield and quality, while it is claimed from work in the U.S.A. (4) that early attacks may cause serious damage to the root system of the young plant with a consequent considerable reduction in grain yield. There is very little evidence, however, on the extent to which a crop that is heavily attacked in early growth can compensate if it develops mature plant resistance, but it is doubtful if anything like full recompense could be achieved. But apart from relative degrees of damage at different stages of growth, seedling tests showing resistance are of the greatest value in separating the completely resistant from the wholly susceptible and the mature-plant resistant groups, though the relative risks run by growing varieties in the two latter categories cannot be determined. However, there is no alternative to this method because no satisfactory artificial tests exist for mature plants.

Cambridge Seedling Tests The seedling tests conducted at Cambridge with forty-two varieties and six physiological races have demonstrated many combinations of strain resistance in the various varieties. The majority of the varieties included in these tests were of French or continental origin. Most of them were susceptible as seedlings to the majority of the physiological races used in the tests, and varieties, such as *Bersée*, *Druchamp* and *Jubilégem* were susceptible to all the races used. Certain varieties, such as *Franc Nord*, *Nord Desprez*, and *Petit Quin Quin* were susceptible to certain races and resistant to others. On the other hand, the varieties *Liberateur*, *Marival*, and *Soissonais* were resistant to all races. This suggests that these three wheat varieties carry some factor for disease resistance not seen in the other varieties under test. There is, however, nothing in their pedigrees to suggest a common ancestor from which this resistance might have been inherited.

The significance of such tests in wheat breeding is well shown by observations on hybrid and parental material at the Plant Breeding Institute. Before the inoculation tests on varieties had been carried out, a cross had been made between the varieties *Holdfast* and *Jubilégem* to combine the good milling and baking qualities of the former variety with the shorter straw, red grain and possibly higher yield of the latter. Although *Holdfast* is known to show considerable mature-plant resistance in the field, it shows seedling susceptibility to four races, while *Jubilégem* is seedling susceptible to all six races and is also susceptible in the mature-plant stage. During the

early generations of this cross there was little natural Yellow Rust infection, and therefore no critical selection for resistance was possible. But in the fourth generation, in 1949, a heavy infection starting at the end of April enabled observations to be made on seedling and mature plant reaction. These field observations corroborated the artificial seedling tests in that all resistant seedlings remained resistant throughout development, while some of the susceptible seedlings developed resistance later. Samples were retained of hybrid cultures showing susceptibility, and of those showing both types of resistance. The results obtained in the following generation, in 1950, when the rust attack developed considerably later, largely agreed with those obtained the previous year, and it seemed that resistant hybrids had been established. But in the following year (1951) a heavy natural infection developed in late June ; all except two of the previously resistant cultures were severely attacked by rust in the mature plant stage. This observation gave an indication, which has been confirmed from other sources, that another race of Yellow Rust to which the material had not previously been exposed was prevalent.

The disappointing results obtained with the *Jubilégem* cross made it essential to take into account the seedling inoculation tests on potential parental material when planning a new series of hybrids involving continental varieties and certain Cambridge hybrids. A wide range of such hybrids was made, in which both susceptible and resistant foreign varieties were used. This material was exposed in its second generation in 1951 to the late developing natural infection of rust referred to above. On July 14, counts were made of the number of plants showing mature-plant resistance by noting the absence of Yellow Rust on the flag leaf. The percentage infection for some of the crosses and their parents is shown in the table. The results

Yellow Rust Attack, 1951

Percentage of Plants with Flag Leaves Infected with Yellow Rust, July 14, 1951

	Percentage Infected		*Percentage Infected*
F_2 *Jubilégem* × W.298/5A	75.7	*Jubilégem*	72.8
F_2 *Jubilégem* × W.298/6A	36.7	*Soissonais*	Nil
F_2 *Soissonais* × W.298/5A	8.5	*Druchamp*	8.2
F_2 *Soissonais* × W.298/6A	18.5		
F_2 *Druchamp* × W.298/5A	32.3	W.298/5A	48.4
F_2 *Druchamp* × W.298/6A	20.6	W.298/6A	24.2

indicate a very close relationship between the behaviour of the second generation populations and the rust reaction of their parents. Thus the second generation population showing the highest percentage of susceptible plants is that from *Jubilégem*, which is highly susceptible in the seedling stage and susceptible throughout development, and W.298/5A which is susceptible as a seedling but acquires some resistance later. The most resistant second generation population, on the other hand, is from W.298/5A and *Soissonais*, which is resistant throughout its development. The intermediate pair of hybrids involve the use of *Druchamp*, which is seedling susceptible and mature-plant resistant.

The picture is not as straightforward as it might be if the genetic basis of inheritance were simpler. Thus, although the difference in susceptibility of W.298/5A and W.298/6A is reflected in the crosses of these two wheats with

Jubilégem and with *Druchamp*, this consistency is broken in the crosses with *Soissonais*. Complications of this kind are, however, likely to occur since in some crosses, greater susceptibility than that of either parent has been obtained, entailing the necessity to discard the whole of the progeny from one cross, and the great majority from others.

The problems which arise in avoiding the damage which could be caused by widespread and recurrent attacks by Yellow Rust in wheat are relevant to other diseases and other crops. Responsibility for ensuring that losses to the farmer and the consumer do not occur through the cultivation of varieties particularly susceptible to diseases must rest primarily on the plant breeder and those responsible for introducing new varieties into agriculture. It is not sufficient for new varieties to show improvement in certain characters while the important attribute of disease resistance is neglected. Not only may the advantages of such characters as stronger straw and higher yield be more than outweighed by susceptibility to certain diseases in any variety, but the cultivation of such a susceptible variety may change the prevalence of the disease through altering the balance of physiological races. The cultivation of disease-resistant varieties is not only the most efficient method of disease control, but it is the surest way of preventing comparatively unimportant diseases from causing highly wasteful epidemic outbreaks responsible for heavy crop losses.

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TOMATOES IN JERSEY

T. Small, D.Sc.
Experimental Station, Jersey

Despite temporary setbacks, the tomato-growing industry in Jersey has steadily advanced during the past fifty years until today between 30,000 and 40,000 tons of fruit are exported annually from the island. The greater part of the crop is grown out of doors, and consequently the yield varies and the wastage, due to imperfect or green fruit, is liable to be high.

JERSEY has only a small area under glass, almost all tomatoes being cultivated out of doors. Reliable information on the early days of the industry is difficult to obtain, but Shepard* states that tomatoes were first mentioned in the reports of the Royal Jersey Agricultural Society in 1901, and that during 1911 nearly 6,000 tons, to the value of £72,586, were exported. After the 1914–18 war, the crop rapidly increased in importance ; by 1933 about 2,000 acres were being planted and 30,000 tons of tomatoes exported. During the German occupation from 1940–45, very few tomatoes were grown, but the liberation saw a further increase in cultivation, as the following figures show :

* H. G. Shepard (1934). *One Hundred Years of the Royal Jersey Agricultural and Horticultural Society*, 1833-1933.

Year	*Acres*	*Export (tons)*
1939	2,968	31,000
1947	2,868	44,590
1948	3,740	35,239
1949	4,112	30,608
1950	3,412	29,179

Although in 1949 about sixty million tomatoes were planted, i.e., more than one thousand for each person living on the island, the returns were comparatively poor and this, together with further low returns in 1950, resulted in a decreased acreage in 1950 and 1951. Cultural and other practices vary considerably from farm to farm but this article describes the more usual methods.

Soil and Manuring The soil of the island ranges from almost pure sand to medium loam and, except for certain small areas, it is acid (*p*H 5.5–6.0). Tomatoes are grown in many parts of the island but especially in the lighter soils near the south, east, and west coasts. Excellent yields are obtained on the heavier soils, but the fruit is slower to ripen and is inclined to be larger and coarser. Often the crop is grown on the same land year after year and it is known that, in a few cases, there has been no change of site for forty or more consecutive seasons.

The lack of bulky organic manure is a problem, particularly on light soil and where no cattle are kept ; in recent years, quick-growing crops such as Italian ryegrass have been sown among the tomatoes in late August or in September and ploughed in during the following spring. Heavy applications of wet or dry seaweed are common but the former is considered too cold for the heavier land. Stable manure is used sparingly since it is liable to result in too much growth.

Basic slag, at the rate of 15 cwt. per acre, is often used on moderately acid soils. The fertilizer dressings depend, among other things, on the type of crop grown. Second-crop tomatoes—those which immediately follow early potatoes lifted in May or early June—frequently depend on the residue left by the potatoes, and receive no additional fertilizers except perhaps a top dressing when the fruit is forming. On the other hand, first-crop tomatoes, planted earlier in the season, are given fairly heavy applications. The following is a popular mixture used at a rate of up to 10 cwt. per acre :

	per cent		*per cent*
Nitrate of Soda ..	5	Bone-flour ..	10
Sulphate of Ammonia	10	Bonemeal ..	20
Castor Meal	5	Sulphate of Potash	10
Superphosphate ..	30	Muriate of Potash	10

Top dressings are given when required.

Varieties New varieties are constantly being tested on a small scale by the growers themselves, but by far the most popular varieties at present are Sunrise, Devon Surprise, and Potato Leaf. The Jersey strain of Sunrise gives high-quality fruit, but the skin is thin and liable to crack, and for this reason many growers prefer Devon Surprise, the fruit of which, although rather coarser and less perfect in shape, remains firm when ripe. Potato Leaf is comparatively new on the island ; the fruit is of the Sunrise type, and although the foliage is large, the growth is "open". Many growers save their own seed every year, a common practice being to select fruit from the first to third trusses of a good row of plants.

Propagation Mixtures of sand, loam, decayed organic matter or peat, plus a little phosphate and potash, are used ; they are sometimes steam-sterilized or "baked," but many growers do not take this precaution. The plants are raised in cold glasshouses which are heated at night in the early part of the season by paraffin stoves.

The seed is sown in batches, starting in February, with intervals between batches. It is usually sown thickly in boxes 2 feet × 1 foot, and later the seedlings are pricked off (average 65 per box) into boxes which are similar in size but which have four 7-inch pillars at the corners and a handle across the top ; the soil in these boxes is often less than 2 inches deep. In the last two years, some growers have raised a part of their crop in soil blocks and the results have been very promising. The disadvantages are that far more propagating soil and space are needed—important considerations for a grower who quite often raises 100,000–200,000 plants. After pricking out, the seedlings remain in the glasshouse for a few days before being transferred to cold frames ; later, the young plants are hardened off in sheltered places which are usually surrounded by, and sometimes covered with, hessian canvas.

Not all growers raise their own plants however ; large numbers of plants are cultivated and sold by nurserymen.

Planting In sheltered areas and on hill slopes, planting begins in April, but with most of the crop it takes place from early May up to mid-June, which many experienced growers consider to be the latest safe date. Later plantings may fail to ripen except in rare seasons when good weather continues into late autumn.

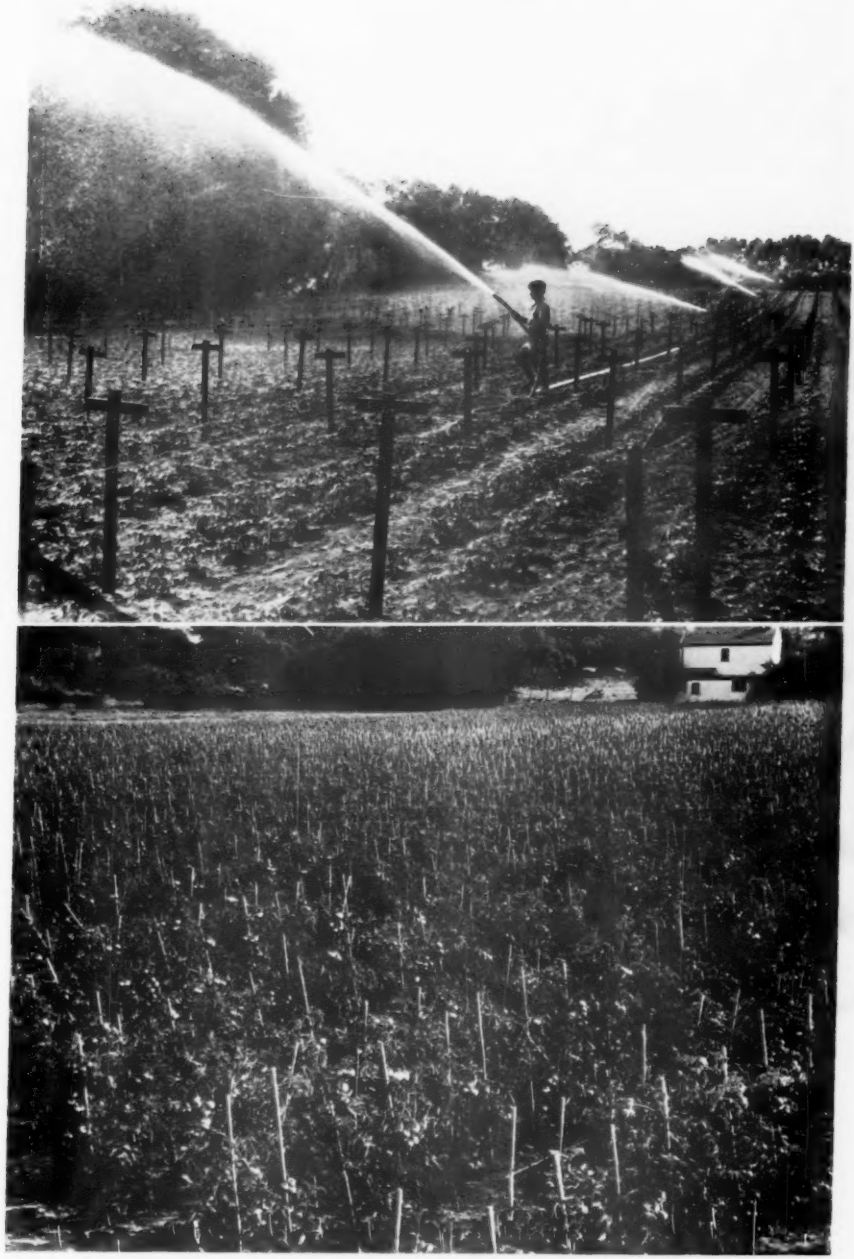
The boxes of young plants are thoroughly soaked with water a day or so before transplanting begins. The plants, about 8 inches high and with very little soil attached to the roots, are taken from the boxes by hand and planted in slits made by thrusting the spade into the soil and levering it from side to side. Another method is to plant in spade-holes 3 inches deep. Trowel planting is seldom used. Gangs of two or three workers operate together : the first worker makes the holes, the second transfers the plants from the box to the holes and either he or the third worker sets the plant. Working on such a large scale, the planting must be carried out quickly—in contrast to glasshouse culture, where every care must be taken ; in fact, the tomatoes are sometimes planted on the day following the lifting of the early potatoes.

The young plants are not watered-in except in very dry years. During the season, the crop is dependent on the rainfall ; sprinklers (see p. ii of art inset) and shallow irrigation channels have been tried but are not popular.

Methods of Cultivation The plants are placed 12–15 inches apart either in single rows 2¾–3 feet apart, or in double rows, 16–18 inches apart with one separated from the next double row by a path 2¾–3 feet wide (see p. ii of art inset). The average number of plants per acre is 14,500, but there is a tendency to increase this in recent years.

Staking is carried out very soon after planting. Each plant is supported by either a bamboo cane (4½ feet long) or wire and string. The wire is fixed to wooden stakes (4 feet long) with a 12-inch cross piece near the top. These stakes are driven into the soil to a depth of 9–12 inches and at distances of about 18 feet along the double rows of plants ; two strands of wire are then run along the whole length of the rows (see p. i of art inset). String is tied near the foot of each plant and to the wire above, so that as the plant

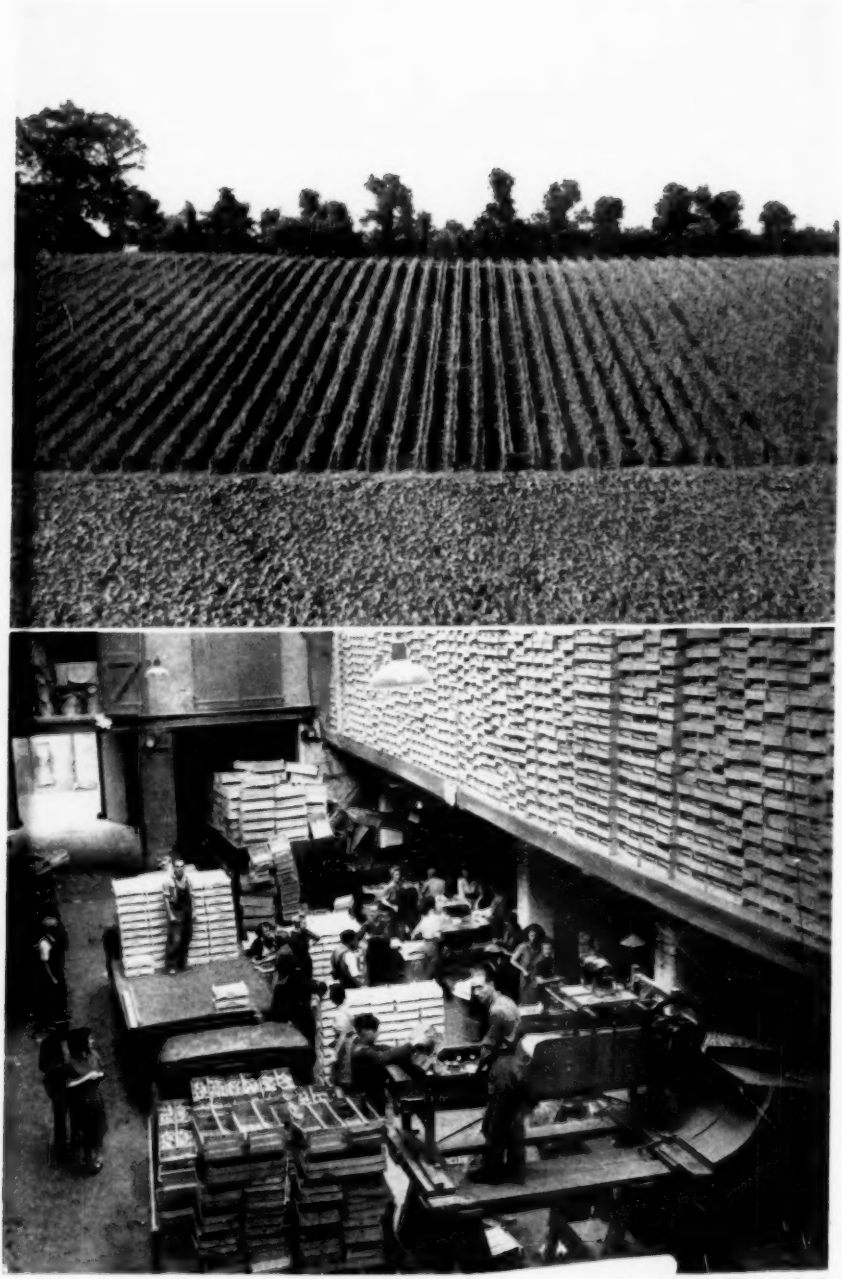
OUTDOOR TOMATOES IN JERSEY



Photos : *Jersey "Evening Post"*

The plants are staked soon after planting

Top: By wooden stakes and wire
Bottom: By bamboo canes



Photos : *Jersey "Evening Post"*

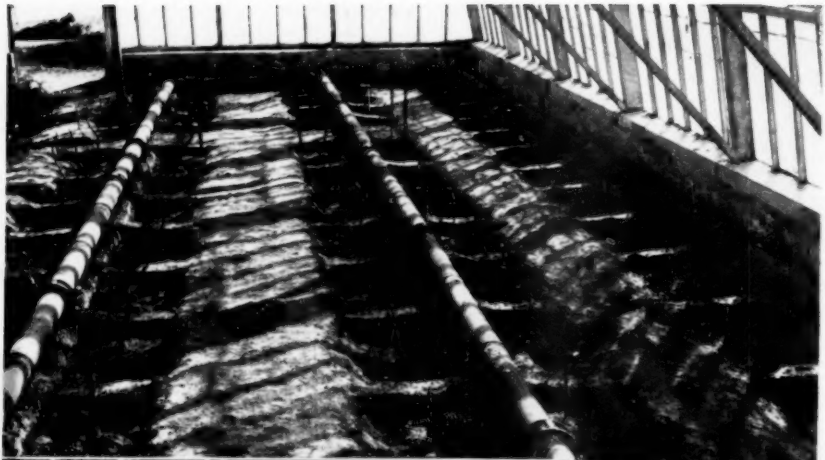
Top: Example of double-row cultivation

Bottom: Cleaning, grading and packing in a merchant's store

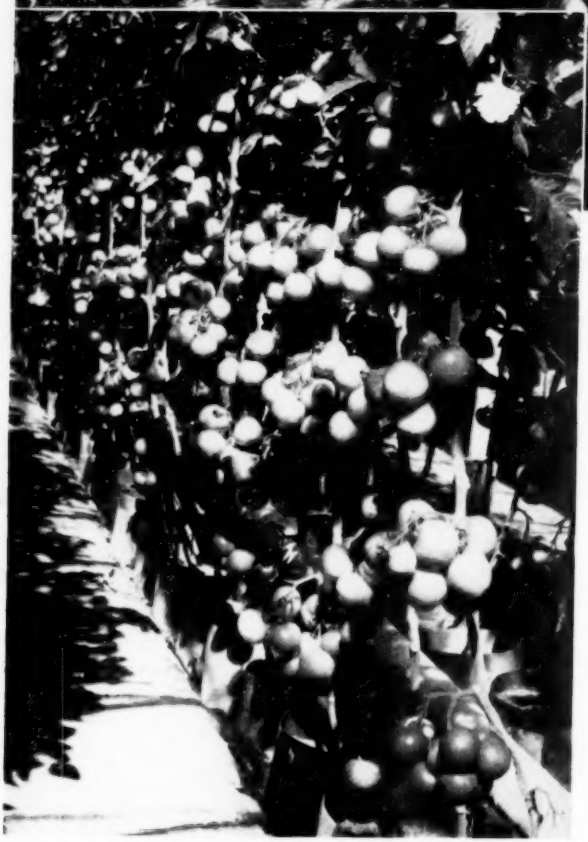
TOMATOES UNDER GLASS IN GUERNSEY

Top: A Guernsey glasshouse under construction

Bottom: Aerial view of a nursery showing how the shape of the field has influenced the siting of the glasshouse (Photo : *Guernsey Press Co. Ltd*)



Top: Trenches at the end of the season. Note how well the cross banks have lasted. These, with the soil under the hot-water pipes, will be broken up before sterilizing



Photos: *E. A. Wheadon*

Bottom: A good crop of Potential growing in 8-inch cardboard containers

grows it can be twisted around the string. This method of staking is far cheaper than using bamboos, but is rather less suitable in exposed windy places.

As in greenhouse culture, the plants are grown on the single-stem system. All side shoots are removed and the plants stopped at either the third or fourth truss, seldom at the fifth. Removal of the lower foliage is rarely practised but in recent years it has been occasionally carried out in an attempt to reduce attacks of Stem Rot (*Didymella lycopersici*), *Botrytis*, and Altenaria Blight (*Altenaria solani*). The work of trimming and tying is paid for at piece rates based on an agreed sum per thousand plants.

A costly but essential factor in the growing of outdoor tomatoes in Jersey is spraying, since the crop is very susceptible to Blight (*P. infestans*), and the growers know from long experience that neglect of this operation is likely to have disastrous consequences. Spraying is frequently started with the young plants in the box stage, and it is not unusual to give twelve or more treatments during the season. Both sprays and dusts are used and losses due to Blight are rare. Other serious diseases and pests, especially Stem Rot and Potato Root Eelworm, attack the crop, but a description of these is not possible here.

Harvesting and Yields The time at which harvesting begins varies from season to season but usually it is about mid-August. September is the peak period, and in favourable years picking may continue until early November. The fruit is gathered into baskets and then tipped gently into boxes which are similar to those described on page 578 but have higher sides. These are taken to merchants' stores in St. Helier or, less frequently, to packing sheds on the farms. Here, the produce is cleaned and graded by machines, and packed into 12-lb. Dutch trays ; some 24-lb. trays are also used (see p. ii of art inset). All packing stores are inspected and licensed, and the packed produce is inspected by officials of the Department of Agriculture immediately before export.

As must be expected with outdoor crops, the yields vary considerably from year to year ; first-crop yields are naturally higher than those of second crops. The proportion of waste is high because of disease, cracking, blemishes, irregular ripening, over-ripeness, etc., and the amount of green fruit which remains on the plants at the end of the season. As yet, there is no satisfactory method of ripening the green fruit—ethylene gas chambers and other methods have been tried but with little success. It is scarcely possible, therefore, to give even an approximate production figure but, in general, the grower estimates exports at about one ton of fruit from each thousand plants grown.

"AGRICULTURE" INDEX

The Index to Volume LVIII will be issued with the April number.

TOMATOES IN GUERNSEY

E. A. WHEADON

Vice-President, Guernsey Growers' Association

Guernsey, situated some 20 miles north-west of Jersey, specializes in the cultivation of hothouse tomatoes. The plants are grown in pots or trenches in distinctive single-span houses with artificial watering, and many of the growers consistently enjoy yields of 50–55 tons per acre.

PROBABLY the first commercial crop of tomatoes grown in Guernsey was that which a Mr. J. Hodges raised in 1874 as a catch crop under vines. The new crop soon gained popularity : the 1890s saw the extensive building of glasshouses, and four years later the Guernsey Growers' Association was formed. Today, the cultivation of hothouse tomatoes (few are grown out of doors) is the main industry of the island. Of its total area of 30 square miles, 900 acres are under glass—the equivalent of one continuous glasshouse 250 miles long and 30 feet wide—and the annual yield exceeds 7 million 12-lb. packs (38,000 tons). By far the greatest proportion of this output is exported between April and the middle of August, with the peak shipments usually occurring some time between June 10 and July 7. The earlier crops which were grown before 1939 are no longer possible because of the shortage of fuel.

Most of the island's glasshouses are concentrated on the low-lying land of the north and north-west in the parishes of St. Sampsons, Vale and Câtel, with the remainder being distributed fairly evenly throughout the rest of the island. The majority of holdings are small ; of the present 1,900 nurseries, 1,050 are less than one-third of an acre in size, and only 250 exceed two-thirds of an acre. Many of them are constructed on land which is liable to flooding, but most of these are raised on a foundation of quarry rubble, the plants being grown in pots. Opinions on orientation are divided, the majority favouring a run north to south, but the observer will soon see that the siting and size of the glasshouses are very much influenced by the shape of the field and the lie of the land (see p. iii of art inset). Since 1936, the building of new glasshouses has been rigidly controlled. In one year, newcomers are now permitted to build on an area of no more than 300 feet × 30 feet, and growers whose glass already exceeds 150 feet × 30 feet are limited to an extension of 150 feet × 30 feet. This restriction does not apply, however, to replacements, for which special permits may be obtained.

The Guernsey type of glasshouse is distinctive (see p. iii of art inset) ; it consists of a single span, 30–40 feet wide and 100–200 feet or more in length, and entirely free from internal obstruction such as purlin posts. Today, a house with a width of 28 feet is generally regarded as suitable for six equally-spaced hot-water pipes and ten long rows of plants. Its distinguishing structural features are the rafters (2½ inches × 7 inches), placed between every four or five panes and the small roof-bars (1¼ inches × 2¼ inches). The older houses were glazed with panes 12 inches × 20 inches, but today, glass panes 18 inches × 20 inches are generally used. It is claimed that this single house is easy to heat efficiently, and economical to fumigate. Although glasshouses constructed with iron, aluminium, and concrete can be found on the island, most local growers prefer the traditional Guernsey pattern ; all houses are permanent structures.

Boilers and heating installations of many different types have been introduced recently, but the most commonly used is still the familiar horticultural

tubular boiler, not infrequently found with a forced-draught unit. The 4-inch hot-water pipes, used for both flow and return, are laid just clear of the soil, this low position generally being considered to provide an effective degree of soil heating, particularly noticeable at planting time. The 1951–52 fuel ration per acre is 13½ tons of steam coal for sterilizing, and 112 tons of anthracite, and 30 tons of coke or coke brees.

There is no artesian water supply on the island, and many wells below sea level are liable to be brackish. Most nurseries have surface wells varying in depth from 20 to 80 feet, some of which tend to run low in summer. During the drought of 1949 many failed, and to guard against such eventualities some growers have built large cisterns to collect the rain that falls on the glasshouses. Although this is unhygienic, it appears necessary to the water economy. The States Water Board service is used by some to augment their own supply or to provide an alternative in case of need. This public supply is drawn from numerous wells, most of the island's streams, large disused granite quarries, and a recently completed impounding reservoir with a capacity of 240 million gallons. Others who depend entirely on the public supply often provide towers for storage against the risk of poor pressure, service breakdowns or cuts in times of drought.

Disinfecting and Sterilizing Methods of disinfecting and sterilizing vary greatly among the growers, but at the end of the season it is usual for the houses of old plants to be fumigated with sulphur or sprayed with formaldehyde. A great effort is made to burn or bury the haulms effectively—an important matter in such a concentrated glasshouse area. After sterilization, the houses are sprayed again, special attention being paid to the structure ; and all staging, boxes, pots, etc., that go into the propagating house are carefully disinfected.

All propagating soil is steamed, and because of the prevalence of diseases such as Verticillium Wilt, cropping soil is also sterilized with steam or formaldehyde. Where Root Knot Eelworm is present and steaming cannot be carried out, an insecticide such as carbon-bisulphide or a recent introduction, D.D., is applied as well as formaldehyde. Many other disinfectants are also employed. Soil for propagating and for No. 8 pots is generally heaped and steamed outdoors during July, August and September.

Where crops are grown in the "floor," usually only the "trenches" are steamed (see p. iv of art inset). The latter consist of strips of soil, about 1 foot wide, on either side of the hot-water pipe which, together with the soil underneath the pipes, makes a total width of about 2 feet 4 inches. After the bottom spit has been forked, the steaming grids are laid about 1 foot below the surface. The paths are often left untouched for years, and although they provide a potential source of reinfection, Guernsey growers get away with it. Verticillium is perhaps the greatest enemy, but fortunately its progress into the steamed soil is normally checked by high spring temperatures in time to prevent serious damage ; in late, cold springs, however, the incidence of this disease may be alarming. Experience has shown that trenches *must* be steamed or treated with formaldehyde every year without exception ; otherwise, they become so seriously infected that the subsequent crop is a dismal failure. In spite of its inherent weaknesses, this method is widely adopted and yields consistently good crops. Many growers have maintained between 50 and 55 tons per acre for ten or more consecutive seasons (except during the German occupation), some obtain 60 to 70 tons, and a few houses yield as much as 80 tons.

Soil and Manures The soil of Guernsey is mostly light and easy to work, but it varies from the sand of the coastal dunes to a heavy, difficult soil in parts of the higher parishes. Every year, though, crops of equal excellence can be found on all soil types within this range. Quick drainage after watering is considered of great importance, especially in pot culture in which sand or gravel is used, generally at the rate of 1–2 cubic yards to 12 cubic yards of soil (1,000 No. 8 pots). But those who plant in the "floor" do not lighten the soil to the same extent.

In the absence of stable manure, straw, composted or as long chaff, is used by some growers, often with marked success ; since the last war, peat has been used extensively, usually at moderate rates such as 1½–3 tons per acre. Lime is applied either in the traditional way as hydrate before winter soaking, or afterwards as carbonate. But most of our glasshouse soils have a *p*H of 7–8 so that it is doubtful if they require such regular applications.

Nitrogen, phosphate and potash are maintained in much the same way as in other districts, and considerable value is placed on such organic fertilizers as hoof and horn, dried blood, bonemeal and dissolved bone. Most of the proprietary brands of manures are known and used here. A base fertilizer is usually applied at the rate of 1–3 tons per acre and worked into the trenches only, and feeding normally begins with a balanced feeder, which often has extra potash added (10–12 per cent K_2O). Nitrogen is rarely omitted because the light intensity is often strong after the third week in February.

Propagating The hothouse crop is sown during November and December, and the very much smaller coldhouse crop between Christmas and the end of January. Seed is sown in standard propagating boxes at the rate of 200–300 per box, and the general practice is to prick out at 28 per box, the plants being ready for planting 8 weeks after sowing. Many of the nurseries are small, and these growers do not raise their own seedlings or plants ; but the plant raiser can be relied upon to sell produce as good as he himself uses. Although the present trend is towards pot plants, usually 48s, wide interest is being taken in soil blocks and 4-inch cardboard cubes. Planting rates for Potentate are 14,000–16,000, and for smooth varieties, 13,000–14,000 per acre.

Cultivation Methods About one-quarter of the crop is grown in No. 8 pots or similar containers which not only provide an effective method of soil heating, but, by restricting the root run, also encourage early cropping. A few growers stand the pots on concrete strips to prevent rooting through, but as this method requires great cultural skill and attention to watering, it is more common to place the containers on a steamed trench designed to form a second spit. In this case, rooting through is often prevented until the second, third or even fourth truss begins to set, the practice varying according to variety, season and individual opinion. As full bearing approaches, pot-grown plants often require daily watering except, perhaps, where early rooting through has been allowed. The remainder of the crop is usually cultivated in trenches which, after sterilization, have been soaked and had a base fertilizer worked in. A system of firm banks is then made on the surface (see p. iv of art inset) so as to form shallow troughs about 3 inches deep. This facilitates control when watering, prevents the water spreading in all directions (as it might if the surface were level) and also enables enough water to be held to penetrate 12 inches or deeper if required. When watering, care is taken to regulate the flow so that

the surface of the soil is not disturbed unduly. Rates of watering are self-descriptive, like " ball watering " ; " just cover ground " ; " half fill the trench " ; or " fill the trenches". Frequency of watering varies with the age of the plants and with the season ; it may be as often as three times a week at the height of the season. The trench system is popular on all well-drained sites but it naturally fails where there is a high water-table. In such circumstances the 3-inch-deep trench becomes a disadvantage, and accordingly, the growing area is often made level with the paths, or planting may even be done on ridges.

To maintain regular setting, overhead damping is generally practised until the fires are put out about mid-June. From then onwards, the danger of *Cladosporium* and *Botrytis* increases, and to forestall this, all the leaves are removed for 2 or 3 feet from the ground thus allowing free ventilation among the plants. If *Cladosporium* appears, panes of glass are removed from between alternate rafters at the front to improve the circulation of air.

Varieties Undoubtedly the favourite variety being grown at present is Potentate. Its exceptional popularity is possibly due to the way in which it so readily develops its bottom crop—a characteristic common to most of the varieties that have gained general favour here, such as Best of All, Improved Tuckswood, Falcon and Baby Lea. Choice of variety is, of course, greatly influenced by circumstances, and in the past, when only early crops paid, Kondine Red, Best of All and Potentate were the varieties most generally selected.

Among the all-round varieties grown are Stoner's Moneymaker, Brouard's Champion, Radio, Charley's Own, Northerner, Kondail, Watsons, Eagle, E.S.5, Plumpton King, Clibran's Victory, and the new variety Potential. Some growers plant up a proportion of their houses with one of these varieties, and a few grow nothing else. All can yield good crops of excellent quality and pleasing appearance, in which both grower and staff take great pride. It is strange that Ailsa Craig, so long popular in the Lea Valley, is rarely grown here.

Little or no seasonal labour is employed, although members of the grower's and employee's families are often recruited for grading and packing. A considerable amount of overtime is done, but the work is congenial and good opportunities for promotion exist. Today, there is a ready interchange of ideas between growers, their neighbours, visitors, and employees. Lectures and discussions are well attended, and it can be truly said that the tomato-growing industry contributes much to the happiness and prosperity of the community.

EXPERIMENTS ON THE MANURING OF PEAS

E. M. CROWTHER, D.Sc., F.R.I.C.
Rothamsted Experimental Station, Harpenden, Herts

J. D. REYNOLDS, N.D.A., C.D.A. (Hons.)
Home Grown Threshed Peas Joint Committee, Peterborough

and

R. W. SHORROCK, M.A., Dip.Agric.*
Pest Control Limited, Cambridge

Experiments on the effect of applying nitrogen, phosphorus and potassium to threshed peas, in various combinations and rates, show that there is little justification for the heavy dressings of fertilizers which are often given for this crop. Other experiments suggest that the commonly adopted method of broadcasting fertilizers shortly before sowing is generally inefficient.

THE acreage of threshed peas in Britain increased from 20,000 acres in 1939 to 160,000 acres in 1946. In a summary of the results of field experiments on the manuring of peas and beans up to 1945, Boyd(1) drew attention to the scantiness of the data and the need for more experiments. Under the aegis of the Agricultural Improvement Council, a series of twenty-five field experiments was carried out on threshed peas from 1946 to 1949 inclusive, the experiments being planned and analysed at the Rothamsted Experimental Station, and the field work being carried out by the Home Grown Threshed Peas Joint Committee in conjunction with the National Agricultural Advisory Service.

These experiments were of uniform pattern and tested the twenty-seven combinations of the three factors N, P and K, each applied at three different rates. The rates of application per acre being as follows :

N_0 = No nitrogen
N_1 = 0.2 cwt. N, as 1 cwt. ammonium sulphate
N_2 = 0.4 cwt. N, as 2 cwt. ammonium sulphate

P_0 = No phosphorus
P_1 = 0.5 cwt. P_2O_5, as 2.5 cwt. superphosphate
P_2 = 1.0 cwt. P_2O_5, as 5.0 cwt. superphosphate

K_0 = No potassium
K_1 = 0.6 cwt. K_2O, as 1 cwt. potassium chloride
K_2 = 1.2 cwt. K_2O, as 2 cwt. potassium chloride

The twenty-seven plots were laid out in three blocks of nine plots, contrasts due to certain high-order interactions being identified with those between blocks. The individual plots were one-twentieth acre in 1946–48, and one-fortieth acre in 1949. Usually, plots were two drill-widths wide and, by blocking the end coulters of the drill, paths were left between plots to facilitate observations and separation at harvest.

Sites were marked out in early spring and the various fertilizer mixtures generally applied on ploughed or roughly cultivated land some days before drilling the seed, the fertilizer being incorporated with the soil by the normal

*Formerly with the Home Grown Threshed Peas Joint Committee.

seedbed cultivations. Sometimes, fertilizer had to be applied on the same day as sowing, and occasionally several days afterwards. No other manures were given, except at two centres where one had received dung and the other superphosphate.

Marrowfat peas were sown at most centres and Dutch Blue varieties at a few. At harvest, the normal procedure was to cut and windrow the plots, obtaining the yields by using a combine harvester with pick-up attachment. With some experiments, the produce was built on to Four-Poles prior to threshing by combine or stationary thresher.

General Results The general results of twenty-five experiments at three centres on contrasting soil types in the eastern counties, from the Holderness district of East Yorkshire to Essex, are summarized in Table 1, which gives the average yields of all experiments in each season and in all years for the three rates (0, 1, 2) of each fertilizer.

Nitrogen fertilizer improved the average yields slightly in the dry season of 1947, but in each of the other three seasons, plots with nitrogen gave rather lower yields than plots without. Superphosphate increased the average yields in 1946 only, but in this year the three centres gave highly discordant results, one centre showing a large gain, another a moderate loss, and the third no effect. There were small average gains from potassium chloride in three of the four years.

Table 1

Mean Yields and Interactions for the Main Treatments
(cwt. of peas per acre)

Year:	*1946*	*1947*	*1948*	*1949*	*All Years*
Number of experiments:	3	8	7	7	25
Mean Yields:					
N_0	20.9	14.5	16.1	17.2	16.5
N_1	19.9	14.7	16.1	16.8	16.3
N_2	19.8	15.4	15.8	16.8	16.4
P_0	18.5	14.9	16.0	16.6	16.1
P_1	20.9	14.7	16.0	17.4	16.6
P_2	21.2	15.0	15.9	16.8	16.5
K_0	19.1	14.5	15.3	17.0	16.0
K_1	19.8	15.2	16.2	17.2	16.6
K_2	21.6	14.8	16.5	16.7	16.6
Interactions:					
N_1P_1	0.3	−0.2	0.1	−0.3	−0.0
N_1K_1	1.3	0.1	0.3	0.2	0.2
P_1K_1	0.7	−0.6	−0.0	−0.3	−0.2

The interactions, which measure the extent to which the benefit from one fertilizer depends on the presence of another fertilizer, were so small and irregular that they may be neglected. There is no clear evidence here for any optimal balance between fertilizers for peas, and the nutrients may thus be considered separately.

The variations between the results at individual centres are shown in Table 2 as the size-distribution of responses to each of the fertilizers at the double rate.

Table 2

Numbers of Experiments showing Increases or Decreases in Yield by Fertilizers at Double Rates

cwt. of peas per acre	*Nitrogen*	*Phosphorus*	*Potassium*
Increases			
2.0 and over	2	2	3
1.0 to 1.9	4	5	4
0.0 to 0.9	6	5	13
Decreases			
−1.0 to −0.1	8	10	4
−2.0 to −1.1	2	2	0
−2.1 and greater	3	1	1
Number of significant increases ..	3	2	5
Number of significant decreases ..	4	3	1

There was no indication of any consistent benefit from either the nitrogen or phosphate fertilizers ; positive and negative differences occurred with about equal frequency. This was true even where the differences due to nitrogen or phosphorus were relatively large by comparison with the inevitable variations between similarly manured plots and were, therefore, judged to be significant.

Ammonium sulphate significantly increased the yields in three experiments in 1947, but it reduced yields significantly in one or two experiments in each of the other years. However, 1947 was a year of unusual weather conditions, an acute drought following an abnormally wet winter and early spring. The seedbeds may have been very deficient in available nitrogen, and the addition of a nitrogen fertilizer may have helped early growth before the soil dried out. From an examination of local rainfall data over the whole series of experiments, there was some indication that the gains from nitrogen were associated with higher rainfall in spring (March and April).

There was no evidence in these experiments to support the popular practice of giving heavy dressings of superphosphate to peas. Only a single experiment showed a large gain from superphosphate ; at three centres the yields were reduced significantly. Such data gave little opportunity for testing the value of soil analyses in making manurial recommendations for peas and, as might be expected, there was no clear relationship between the results of soil analyses and the effects of superphosphate.

On the average of all twenty-five experiments, 1 cwt. potassium chloride per acre increased the yields of threshed peas by 0.6 cwt. per acre. There was, however, no further increase in yield by doubling the dressing of potassium chloride. In two of the four seasons, the average yields with 2 cwt. potassium chloride were slightly less than those with 1 cwt. At five of the centres, the double dressing of potassium chloride gave significant increases, and there was only one centre in which the yield was significantly reduced by this dressing.

The effects of potassium chloride were related to the results of soil analysis. Seven centres, with soils judged "low" in readily-soluble potassium gave an average gain of 2.1 cwt. peas per acre from 2 cwt. potassium chloride per acre, whilst potassium chloride had little or no effect on the average of the other centres with soils showing "medium" or "high" readily-soluble potassium.

The series of experiments as a whole showed that there is little justification for giving peas heavy dressings of fertilizer. It is sufficient to add a moderate amount of potassium chloride on soils likely to be deficient in potassium.

As potassium chloride is a troublesome material to apply by itself, it is more convenient to use a granular potassic superphosphate with a high content of potassium. Partly as the consequence of these experiments and related ones, a granular mixture with 10 per cent P_2O_5, 20 per cent K_2O, is now on the market. Three hundredweight of this mixture per acre supply the equivalent of about 1.5 cwt. superphosphate and 1 cwt. potassium chloride per acre, and will generally suffice.

Methods of Application This series of experiments was conducted over four seasons on farms representing the main areas in which threshed peas are grown. The methods of applying fertilizers and the cultural operations were similar to those used on the commercial crops on these farms ; indeed, the experiments were generally laid down within a commercial crop. The poor returns from the fertilizers raise doubts about the efficacy of the methods commonly used in applying fertilizers for peas. In the experiments, the fertilizers were sometimes broadcast immediately before seeding, with nothing beyond a light harrowing or the action of the seed drill to work them into the soil. In a dry spring, the fertilizers would remain uselessly in the surface crust of soil, and the nutrients added could not reach the deeper roots. With a crop sown in wide rows, broadcast fertilizer falling between the rows could be of little value in the critical early stages of growth.

In another series of experiments, Cooke(2) has shown that in some seasons advantages can be obtained from broadcasting fertilizers early and incorporating them deeply with the soil by cultivations given to prepare the seedbed. Alternative methods of drilling fertilizers with or near the seed have also been tested. The simplest method is to drill both fertilizer and seed down the same spout as is done in combine-drilling cereals but, as has been pointed out by Hanley(3) and confirmed by Cooke(2), this method of applying fertilizer, especially when the soil remains dry for some time, may seriously impair the germination and early growth of peas.

In the United States, special placement drills are used for peas, beans, and many other row crops to provide bands of fertilizer at a safe distance from the seed. The National Joint Committee on Fertilizer Application(4) has recommended that for peas sown in narrow rows, fertilizer should be placed in bands half-an-inch to one side of the row and one inch below the seed ; for wide rows, the bands should be on both sides of the seed and two inches away. Cooke(2), using a special experimental drill, has obtained significant yield increases from fertilizers placed in bands about two inches away from the seed in experiments where broadcast fertilizer had very small effects. The extra yield of threshed peas obtained from "placed" compared with "broadcast" fertilizer averaged nearly 2 cwt. per acre in seventeen experiments over four seasons. Drills capable of placing fertilizer in a narrow band at a safe distance from the seed are not yet marketed in Britain. In a paper on " Fertilizer Placement Machinery," Cooke(5) wrote : " A few farmers have modified combined seed and fertilizer grain drills for side-band placement by using every second or third coulter to sow seed, and setting another coulter close beside the seed coulter to place a band of fertilizer in the appropriate position. There is a real need for a commercial drill designed to place fertilizer beside the seed, for peas, beans, swedes and rapidly-maturing market-garden crops. Suitable machines could be designed as trailed implements of conventional pattern. Alternatively, where independent seed-units are mounted on a tool-bar, a fertilizer unit could be incorporated. A few prototype drills of this pattern have been produced."

Summary In a series of twenty-five field experiments on the manuring of peas grown in the main pea-growing localities, there was, on average, no benefit from ammonium sulphate or superphosphate. Potassium chloride, applied at the rate of 1 cwt. per acre, gave an average increase of about 0.6 cwt. peas per acre, but there was no further increase on doubling the dressing. On seven soils judged by soil analysis to be deficient in readily soluble potassium, the double dressing of potassium chloride increased the average yields by about 2.1 cwt. peas per acre ; there was no gain from potassium chloride on the average of the rest of the soils with moderate or high contents of readily soluble potassium.

It is recommended that where peas are to be grown on soils likely to be short of potassium, they should receive about 3 cwt. per acre of a granular potassic superphosphate with a high potash content, e.g., 10 per cent P_2O_5, 20 per cent K_2O.

Broadcasting fertilizers shortly before sowing peas is an inefficient practice. It is better to broadcast the fertilizer at an early stage of preparing the land, working it well into the soil. Other experiments have shown that fertilizer placed in bands about two inches to the side of the seed and a little below it, gives better yields than broadcast fertilizer; but suitable drills are not yet on the market. Placing fertilizer in contact with the seed by combine-drilling cannot be recommended as in dry spells it may check plant establishment.

Our thanks are due to the officers of the National Agricultural Advisory Service who assisted with the field work, and to Mr. J. H. Dunwoody of the Statistics Department, and Mr. R. G. Warren of the Chemistry Department, Rothamsted Experimental Station, for undertaking the statistical and chemical analyses.

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APPLE SCAB SPRAYING COMPETITIONS IN KENT

J. Turnbull

The value of frequent spraying and an adequate circulation of air between the trees in the control of Apple Scab was clearly demonstrated in the results obtained in two Orchard Spraying Competitions held in Kent last year.

METHODS employed to control Apple Scab underwent their severest test for many years during the exceptionally wet weather in 1951. At the same time, a good opportunity to observe some of the results obtained by commercial growers, under various conditions and methods of control, was afforded in Kent by two Orchard Spraying Competitions, arranged by the Cranbrook and Paddock Wood branches of the National Farmers' Union.

The average rainfall in the greater part of these districts is about 31 inches, and in the remainder, about 27 inches, so that, even with normal weather,

the control of Apple Scab is always a problem, especially in the older orchards which are generally situated in sheltered valleys.

A condition of the Competitions was that each competitor should enter all his apple and pear trees, these then being classified into two age groups—5 to 15 years, and those over 15 years. In the two areas, twenty-eight competitors together entered a total of more than one thousand acres of orchard land, which was inspected for pests and diseases by three judges in each competition. Each judge examined a different part of the farms and later met to award points, and place the farms in order of merit. It was found that, commercially speaking, one-third of the entries were free from pests and diseases and another one-third not far below this grade, so that the general standard was high.

It was evident from the entries that most cases of Apple Scab occurred where, owing to a poor circulation of air, moisture did not dry off quickly enough. This condition arose where trees were growing too close together, and where orchards were either in a valley or enclosed by tall, dense hedges. Other factors adversely affecting the control of the disease, although to a much smaller extent, were the excessive use of nitrogen, and the size and variety of the trees. Severe cases of Scab were found on only Bramleys and Laxtons ; most of the former were very large trees, difficult to cover, and often so closely planted in sheltered positions that they were touching one another.

Fungicides Used Lime-sulphur, colloidal and dispersible sulphurs, and copper-lime dust were commonly used in the areas, although, because of the sulphur shortage, various preparations of mercury were also applied at post-blossom stage. All the fungicides gave control in some places but failed in others, so that the choice did not appear to affect the results. Nor was anything gained by applying more than the recommended strengths, even under unfavourable conditions. Mercurial preparations gave good results when sprayed at post-blossom stage on Bramleys, but for general use with Cox's they were too risky. The best result for this variety was obtained in the Paddock Wood Competition, in an orchard which extended to the bottom of a valley, two early sprays of colloidal sulphur instead of lime-sulphur being used to prevent damage to the early, young leaves, followed by seven sprays of dispersible sulphur. The most effective method for Bramleys was seen in the Cranbrook Competition, where lime-sulphur had been sprayed once at a concentration of 4 per cent, three times at 2 per cent, then again at 1 per cent during blossoming ; these applications were followed by three sprays of a mercurial preparation. Many of the trees of this particular entry were situated right in a valley, and the sprays were applied by air blast ; half the usual quantity of dilute wash was used, so that the amount of concentrate was small. The competitor placed fifth in the Cranbrook Competition (the second example in the table on page 591) used three pre-blossom sprays of lime-sulphur at concentrations of 2½ per cent, 2 per cent, and 1½ per cent in that order, then one post-blossom spray at 1 per cent, and two more at ¾ per cent. His Bramleys, which were openly situated, were clean, but his Cox's, in a more sheltered area, showed a trace of Scab. Lime-sulphur thoroughly applied at a concentration of ¾ per cent is less risky on Cox's in the height of summer, but its effect, although fairly good, cannot be expected to persist as long as that of the less dilute sprays which are applied earlier in the year.

Spraying Methods Most competitors sprayed large trees by hand *before* blossoming and employed automatic methods afterwards. However, one winner sprayed automatically throughout, another used air-blast, and a third, hand and automatic methods, so the results cannot be attributed to any specific method of spraying.

In addition to the choice of the fungicide and method to be used, the other factors to be considered in arranging a satisfactory spray programme are, of course, the date of the first spray and the frequency of later sprays. In connection with the former, it is first necessary to ascertain the earliest date of infection by air-borne spores. In 1951, the first spot was seen at the East Malling Research Station on May 2, but a few days might have passed before this was noticed by the ordinary grower. Nine days before (April 23), when the trees were at green-cluster stage, a cold night had followed a warm day, and the ground being very wet, a heavy dew resulted, providing just the right conditions for Scab development. The first spray should, therefore, have been completed before that date. The answer to the question of frequency is easier, and is one that the East Malling Station has been emphasizing for many years now ; that is, spraying should be carried out at intervals of not more than fourteen days, especially in a year favourable to the disease.

Frequency of Spraying Bearing these facts in mind, it is interesting to look at the details in the spray programmes which competitors in the Cranbrook section were required to declare. The table on p. 591 shows six typical programmes, each of which achieved a different standard of freedom from Apple Scab, as indicated by the points awarded. In considering the results, regard must be paid to the variations in the situation of the trees.

It will be seen that in all the programmes except the first, there had been some intervals of more than fourteen days between applications, and it would appear that the longer the gap between sprayings and the fewer the applications in April and May, the worse was the result achieved.

The first programme shows some interesting features. The very early start, made when the leaves were still upright, was due to the inclusion of BHC for aphids which, as the trees had not been winter washed, were then visible outside the buds. The majority of the trees were large Bramleys which, although situated in a valley, had been well spaced by grubbing, so that there was a reasonably good circulation of air ; in consequence, they were as free from pests and diseases as those on higher ground. The plan the grower had adopted was to carry out the spraying at weekly intervals, or, if the weather was unsuitable, to postpone the job for a day or two. Thus two applications were made before the critical date, April 23, another two given before, and one during, the blossom stage, and a further three afterwards. The fungicide, which was applied by air blast, was of the same strength but only half the quantity generally considered necessary with other methods of spraying. A ladder was also used during the work, to enable the grower and his men to see any areas that might otherwise be missed.

A similar programme was used by the Paddock Wood competitor who obtained the cleanest Cox's Orange trees. The trees, on land which sloped into the foot of a valley, were sprayed every eight to ten days commencing at the early green-cluster stage, and continuing through blossoming. Colloidal sulphur was used on the first two occasions, and dispersible sulphur for the

remainder. All this work was done automatically, using fixed nozzles and, to avoid wind, was usually carried out at night—often with the aid of headlights—and in the early morning.

Dates of Spraying
(Cranbrook Competition)

	Development Stage					Points Awarded (Maximum 40)
	Bud-Burst	*Green-Cluster and later*	*Pink-Bud*	*Blossom*	*Petal-Fall and later*	
1	April 10 „ 17	April 26	May 9	May 21	May 31 June 12 „ 26	36
2	April 14	April 28	May 12	—	June 1 „ 16 „ 30	33
3	April 17	April 26 May 4	—	May 23	May 31 June 18 „ 22 July 13	27
4	April 10	April 23 May 3	—	—	May 29 June 19 July 12	20
5	April 12	April 20 May 5	—	May 24	June 22	15
6	April 13	May 4	—	May 25	June 8 „ 18 „ 22 „ 29 July 6 „ 13	8

Both these successful competitors prefer to spray every seven to ten days rather than increase either the concentration or quantity of the wash and apply less frequently. Neither are ideally situated, but both take much trouble to ensure that the work is done well, and in suitable weather.

It was interesting to note that one highly placed competitor, who used a mercurial preparation after the blossom stage, had, in fact, allowed a long interval between two particular sprays without apparent detriment to his fruit. As, however, his Cox's Orange trees suffered some leaf fall, this may well have had the effect of removing scabbed leaves before the disease could attack the fruit—a fortunate occurrence, indeed.

The second spray programme given in the table led to the production of clean Bramleys and other cookers, despite the fact that no treatment was given between pink-bud and petal-fall ; but these trees were in an open and airy position. The Cox's, which were more sheltered, showed signs of a little Scab. The Cox's of the third entrant were clean, being in an open position, but his Bramley's Seedling, which were enclosed in a valley, were rather diseased. The remaining three entries consisted chiefly of large Bramleys in enclosed areas. These results show the effect of situation on the incidence

of the disease, and illustrate clearly the necessity for more thorough work in orchards where there is poor ventilation.

The Lesson The Competitions proved that the two outstanding factors determining the efficiency of Apple Scab control were the conditions in the orchard, and the length of time allowed between sprayings. Minimum treatment was required by small trees situated in open areas where moisture did not linger for hours on end. Thorough attention was necessary with larger trees, especially those growing in sheltered parts, although it was shown that ventilation could often be improved by the removal of useless trees, hedges, and other obstruction.

In both districts the disease was controlled more successfully by increasing the frequency of spray treatment, rather than the quantity of wash. All the fungicides mentioned were effective when applied in accordance with the recommendations of research stations, no advantage being gained by using mixtures of greater strength. The various methods of spraying gave equally good results, but it is noteworthy that, even under adverse conditions, effective control can be maintained by air blast, using only one-half the quantity of the normal solution.

Although in practice it is impossible to achieve one hundred per cent cover with each spray, it was evident that insufficient attention was paid to the use of that small but useful piece of equipment, the ladder, to inspect the tops of trees.

It is important that a farm is adequately equipped for completing one spraying of all the apple trees in three days, and until that is done it is advisable to use dust between sprays, rather than have a long interval when no treatment is given at all. Sulphur dust has proved effective, and is not harmful to Cox's Orange Pippin unless applied very heavily.

FARMING AFFAIRS

Ploughing up of Grassland We must produce more food for man and beast so that we may feed our people to a greater extent from our own acres. This means ploughing up more grass, improving the grass that remains and getting the utmost production possible from every acre. A celebrated farmer-improver of the early nineteenth century said : " Who aims at excellence will be above mediocrity : who aims at mediocrity will fall short of it". This epigram applies with special force to the ploughing up of old grass when, as now, we must set about it rather late. Cultivations must be thorough—turf well buried, furrows disced immediately afterwards, if possible, while the soil is still tender. If two heavy discings and harrowings look enough, give at least one more of each so that a fine, firm, sympathetic tilth is obtained. Thorough disintegration and sub-surface compression are specially important in areas subject to dry spells in May. Cultivation of this order is, of itself, a safeguard from damage by wireworm but as an additional precaution the seed should be dusted with the combined organo-mercury—BHC dressing which protects both from wireworm and from seed-borne disease such as Smut. Late-ploughed grassland may be short of

readily available plant food. Two or three cwt. of National Compound fertilizer per acre, even at present prices, is likely to be well repaid. In no circumstances should fertilizers be withheld from second corn crops, and a nitrogenous application should be given to autumn-sown corn.

On the lighter classes of grassland ploughed up in February or March, barley is likely to answer better than wheat, particularly in the south and it has the further advantage over other cereals that it can be sown as late as May if necessary. In the north, oats are commonly sown after temporary leys, but of all crops, oats are the most susceptible to wireworm infestation. Apart from the protective seed dressing already mentioned, an increased rate of seeding is the best palliative.

For animal provender, a mixture of stiff-strawed oats, heavy yielding barley, spring beans and maple peas sown in March would be likely to do well on land in good heart, and provide a useful supply of both grain and straw. Straw from spring wheat is unsuitable for fodder, but where grain is the paramount consideration a mixture containing 25 per cent of an early variety with 50 per cent barley and the balance peas and oats should make a useful contribution to the animal food supply. Wheat and beans, half and half, have also been a permissible mixture. Legumes are little affected by wireworms and, excepting linseed, are our only protein-rich grains. Linseed is practically immune from attack by wireworm and is also neglected by rabbits. It needs a fine tilth like barley and cannot tolerate weeds. Old grassland ploughed up is generally clean. Thus there is more than one reason why linseed may suitably follow. Sown in April, it has yielded up to 16 cwt. per acre on Chiltern chalkland. It has been harvested by mower, binder, and combine. In all cases harvesting and threshing are facilitated by dry, sunny weather.

For potatoes, ordinary March ploughing of grassland would be considered rather late for ridge ploughing. The undecayed turf would interfere with cultivations. But on allotments, potatoes have often been grown successfully when turf, broken in March, has been put down deep and not brought up again. Allotment cultivation can be closely imitated on a field scale by deep ploughing. This is followed by a second ploughing only three or four inches deep and planting the tubers in the bottom of the furrow. A two-furrow plough can be used but to escape damage, the tubers must be set on the "land" edge so that they can be toppled in next time round. In areas of low rainfall, moisture is better conserved by flat planting than by the usual ridge method. Once the potatoes are well through the ground, they can be earthed up in the usual way. Healthy, vigorous seed, liberal manuring, and early planting are the most important factors in successful potato growing. Early lifting safeguards from wireworm damage.

Loss of grassland to tillage can generally be made good by intensifying production on what remains. In this connection fertilizers, including nitrogen, play the biggest part. We can do with less land in hay or silage if we step up yields. Similarly, by appropriate manurial treatment we can do with less pasture. We can obtain additional grazing that is clean and wholesome if we undersow our corn with a few pounds of Italian ryegrass and trefoil. If a second corn crop is to be taken it might suitably be a spring one, e.g., barley after wheat. In that case the first straw crop might be undersown to provide both autumn and winter grazing, especially for sheep.

The high productivity of roots and green crops, well done on even a smaller area than usual, should not be overlooked, despite the labour and expense involved in growing and feeding them. If concentrates such as

maize or similar coarse grains cannot be bought at any price in quantities needed to maintain the livestock, the economy of such crops can only be judged by the value of the animal product. Even moderate crops of mangolds, fodder beet and kale yield two or three times as much starch equivalent as average grain yields of oats or barley and they are the best means of turning cereal straw, of which there is mostly a superabundance, to useful account.

J. G. Stewart

Farming Cameo : 17. North Bedfordshire

" The north of Bedfordshire is remarkable for cold, wet clays, and late harvests." Since Thomas Batchelor, a Bedfordshire farmer, wrote those words during the Napoleonic wars, technical advances in land drainage and mechanization have increased the farming potentialities of heavy clay land ; but Batchelor's statement remains apt.

Much of North Bedfordshire consists of undulating country made up of drift deposits of Boulder Clay, through which the river Ouse meanders between narrow strips of alluvial land. The latter are frequently flooded and consequently are mainly in grass. Between these river meadows and the clay soils are deposits of valley gravel which give rise to the lightest soils in the district and have been extensively worked for gravel. South and south-west of Bedford the Oxford Clay which underlies most of the district has not been covered by superficial deposits and the difficulty of draining the very stiff clay soils—John Bunyan's original " Slough of Despond "—is increased by the flatness of the land. The tall chimneys of the brickworks tell their own tale of land lost to agriculture.

North Bedfordshire, situated between the arable farming areas of East Anglia and the more pastoral husbandry of the Midlands, reflects both types of farming, the pattern changing gradually from west to east so that, whereas in the north-west grassland plays a large part in farming systems, in the east of the area farms tend to be smaller and to concentrate on arable cash crops, with pigs replacing cattle and sheep as the most common livestock. Though there are some highly specialized farms, most farmers prefer to continue the traditional mixed husbandry of the area.

Market gardening, often regarded by the layman as the only agricultural enterprise in Bedfordshire, accounts for only one-twelfth of the arable land of this district. There is some intensive cropping with vegetables, flowers and early potatoes on the gravel soils, but many horticultural crops, particularly peas and brassicas, are now grown on heavy land. The change from the light soils of East Bedfordshire, where these crops were originally grown, has been due not only to economic and cultural factors but also to the improved cultivation made possible by the introduction of crawler tractors. Brussels sprouts is the most extensively grown vegetable crop, and the district accounts for about 8 per cent of the national acreage : it is principally grown in a rotation on mixed arable farms and is often sold as a standing crop.

About three-quarters of the 99,000 acres in the district is arable. This is not cropped to any set rotation, but cereals, which occupy just over one-half of the arable area, are the mainstay of many arable farmers, being alternated on most farms with clover leys, bare fallow, potatoes, Brussels sprouts, or occasionally beans, according to the accessibility of the land and the labour available. Of the cereals, wheat is by far the most important, but barley growing has increased considerably in the past ten years.

Seed crops of both roots and vegetables are raised in the district, and in the case of mangolds and sugar beet they have become so numerous that a

zoning scheme has had to be introduced to prevent cross-pollination in the two crops and between the various types of mangolds. To prevent aphids spreading Virus Yellows in the steckling beds, spraying or the undersowing of the mother seed in spring barley are often practised. Alternatively, stecklings are grown in Scotland and transported.

The heavy land in this district, in common with much of the clay land of England, has had a chequered history. Its productive future depends on finding capital to finance essential but costly drainage and mechanization; given that capital, though, the land is most responsive. Now that crawler tractors are available, it is hoped that never again will a Batchelor be able to observe that " the occupiers of poor soils such as abound . . . north of the Ouse, are said to be as poor as the soil."

E. R. Bullen
District Advisory Officer

Survey of Upland Farms Between 1944 and 1946 the Farm Mechanization Enquiry of the National Institute of Agricultural Engineering carried out an extensive survey of the work done by horses, tractors and implements on seventy farms in seven different regions of Britain. One of the areas chosen was the hilly country on the borders of Shropshire and Wales, and from this particular survey a report, based upon the day-to-day records on five of these upland farms in the year beginning April, 1945, has now been prepared and published.*

All the holdings selected were stock farms and, with the exception of one of 1,063 acres—an exceptionally large farm for the district—they were between 97 and 231 acres in size. All were situated on similar medium loam soils between 600 and 1,300 feet above sea level with steep gradients and irregular-shaped fields, many of which were difficult of access. With the exception of one or two larger pieces of rough grazing, the fields were small, averaging only 8 acres for arable and temporary grass, and 11 acres for permanent grass. The proportion of arable land on the farms was relatively low, ranging from 18 to 29 per cent, and was mostly devoted to crops for stock feeding. It was distributed fairly evenly over the area and there appeared to be no particular tendency to put the higher fields down to permanent grass.

Tractors had only recently been introduced and there was a shortage of suitable modern implements, most of them having been converted from horse use. Labour was also scarce, so that there was a tendency to concentrate on immediate production to the detriment of long-term maintenance.

The details of the use made of machine and horse, with various crops and on different types of work, are given in the report in a series of concise and clearly-presented tables, each of which is preceded by a short explanation. Among the points they bring out is the fact that, even allowing for differences in management, tractors were not utilized to the full, working an average of only 547½ hours each per year. A considerable amount of the cultivation work and the bulk of the carting was done by horses, and horse implement hours in the year averaged 335½. However, this does not truly indicate the extent to which the horses themselves were worked since often two or three had to be employed on one implement.

* *A Survey of Upland Farms*, 1945. Obtainable from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds, or The Scottish Machinery Testing Station, Howden, Mid Calder, Midlothian, price 2s. 6d., including postage.

Other interesting features of the report are graphs showing the seasonable distribution of the work and the figures of intensity of work in acres per hour of various horse- and tractor-drawn implements. The latter are compared with those obtained in the complete survey of the seventy farms and, with the many difficulties of the upland farmer in this year—the sloping, high, exposed fields, awkward lay-out, bad weather, labour shortage—it is quite surprising to find that the performances on these farms compare very favourably with those recorded on more suitably placed farms.

Discussing the results of the survey, the writer recognizes that the greatest problem to be overcome on these upland farms is that they were laid out for horse work and most of the implements and fields are not suitable for the newly introduced tractor. In the absence of additional labour, he suggests that the only answer lies in improved mechanization, coupled with long-term land improvement schemes and the production of tractors and implements which are capable of operating on the steep slopes and small fields of the district.

Agricultural Scholarships The Ministry of Agriculture and Fisheries invites applications for the following scholarships :

Ten Senior Scholarships for degree or diploma courses in an agricultural subject (degree courses at University Departments of Agriculture, diploma courses at the Agricultural Colleges and the Essex and Lancashire Institutes of Agriculture) ; or for courses in Veterinary Science at Veterinary Colleges.

Six Extended Junior Scholarships (for those who have already held Junior awards), and

Sixty Junior Scholarships, tenable at Farm Institutes, for courses not exceeding one year in duration, in agriculture, horticulture, dairying or poultry husbandry.

The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers whose means and method of livelihood are comparable with those of agricultural workmen, and to persons who are themselves *bona fide* workers in agriculture. The value of awards is assessed on a sliding scale according to the circumstances of the parent, or guardian, and the applicant, Senior awards being comparable to State Scholarships. The usual method of selection is by interview, no written examination being held, but candidates must be able to satisfy the Selection Committee that they will benefit by a course of instruction and that they intend to follow an agricultural pursuit on completion of their training. Candidates must have attained the age of 17 on September 30, 1952.

Full information about the scheme and forms of application may be obtained from the Secretary (Room 314), 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from the Education Offices of County Councils.

The latest date for submitting completed applications is March 31, 1952.

New Legislation Against Foul Brood The importance of doing everything we can to stamp out Foul Brood from British apiaries is reflected in a new Order made by the Minister of Agriculture and Fisheries under Section 11 of the Agriculture (Miscellaneous Provisions) Act, 1941, known as the Foul Brood Disease of Bees Order, 1952.* It provides for the examination of bees, combs and beekeeping equipment by

*Copies are obtainable from H.M. Stationery Office, price 3d. (4½d. by post).

an officer of a County Agricultural Executive Committee, the taking and testing of sample combs, and for the service of a notice prohibiting the removal of bees, combs, honey and equipment where Foul Brood is suspected. If the presence of the disease is confirmed, destruction of the infected bees and combs may be required together with destruction or treatment of the infected equipment.

Other important provisions of the 1952 Order are :

To make systematic inspection possible, County Agricultural Executive Committees may, from February 1, 1952, specify areas for examination without necessarily suspecting that an actual outbreak of disease exists.

Where European Foul Brood Disease is found, a "standstill" notice may be served which will remain in force until the end of the active season following that in which the disease was dealt with. This is to give time for the disease to show itself in any other hives in the apiary in which it may have been present, but not apparent, at the time of the original inspection.

If a beekeeper is convicted for failure to comply with a notice requiring him to destroy or treat infected bees or equipment, the County Agricultural Executive Committee may themselves destroy or treat the infected bees and equipment.

The new Order, which supersedes and revokes the Foul Brood Disease of Bees Order, 1942, is based on a recommendation of the Bee Disease Advisory Committee.

AGRICULTURAL INDEX NUMBERS

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCTS

INCLUDING EXCHEQUER PAYMENTS (UNCORRECTED FOR SEASONAL VARIATION)
BASE 1927-29=100

	1951			1950		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
All Products	280*	302*	311*	257	273	281
Cereals and Farm Crops	257	265	277	230	241	248
Livestock and Livestock Products	288*	315*	323*	268	286	295
Wheat	266	274	282	266	271	273
Barley	380	382	394	275	306	314
Oats	300	300	312	239	241	250
Potatoes	200	210	225	186	191	201
Hay	233	236	237	217	247	255
Fat Cattle	217	214	230	197	197	205
Fat Cows	189	181	188	167	161	161
Fat Sheep	204	204	218	200	200	202
Fat Ewes	197	197	215	191	194	197
Bacon Pigs	346	346*	349*	313	313	313
Pork Pigs	296	296	298	269	269	269
Sows	235	235	238	228	228	228
Milk	315*	357*	365*	297	331	344
Butter	143	143	143	114	114	114
Poultry	266	281	327	267	268	305
Eggs	300	330	330	275	275	266
Store Stock †						
Dairy Cows	194	204	213	180	180	185
Store Cattle	216	215	210	199	201	197
Store Sheep	218	221	227	216	206	208
Store Pigs	378	365	372	398	386	369

* Provisional.
† Not included in general index.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the December, 1951, issue of AGRICULTURE (*p.* 450), *the undermentioned publications have been issued.*

MAJOR PUBLICATIONS. Copies are obtainable, at the prices quoted, from the Sales Offices of H.M. Stationery Office or through any bookseller.

Bulletin

No. 100 Diseases of Bees (*Revised*) 1s. 9d. (1s. 10½d. by post)

Technical Bulletin

No. 1 Specification and Methods of Analysis for Certain Insecticides, Fungicides and Herbicides (*Revised*) 2s. 6d. (2s. 7½d. by post).

Growmore Bulletin

No. 8 Substitute Feedingstuffs (*Revised*) 6d. (7½d. by post)

Other Publications

Pig Husbandry (*New*) 1s. 6d. (1s. 7½d. by post)
More from Every Acre (*New*) 3d. (4½d. by post)

LEAFLETS Up to six single copies of Advisory and Animal Health Leaflets may be obtained free on application to the Ministry (Publications), 36-38 Chester Terrace, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from a Sales Office of H.M. Stationery Office.

Advisory Leaflets

No. 236 Commercial Horticulture : Advice to Beginners (*Revised*)
No. 377 The Pollination of Apples and Pears (*New*)
No. 378 The Pollination of Plums and Cherries (*New*)
No. 380 Chemical Caponization (*New*)
No. 383 Cockroaches (*New*)

Animal Health Leaflet

No. 27 Swine Erysipelas (*Revised*)

FREE ISSUES Obtainable only from the Ministry (Publications), 36-38 Chester Terrace, Regent's Park, London, N.W.1

Farm Machinery Leaflets

No. 12 Platform Driers for Bagged Grain (*New*)
No. 13 Ventilated Silo Grain Driers (*New*)

Growmore Leaflets

No. 84 Rations for Livestock : January—April, 1952 (*Revised*)
No. 103 Approved Hypochlorites in Milk Production (*Revised*)
No. 103a Approved Oxydizing or Preservative Agents (*New*)

CORRIGENDA

The following two publications were incorrectly quoted in the last issue of this list :

Bulletin

No. 130 Threshing and Conditioning of Herbage, Root, and Vegetable Seed Crops

Advisory Leaflet

No. 175 Stem and Bulb Eelworm : Horticultural Crops

BOOK REVIEWS

History of Dairy Shorthorn Cattle. G. T. BURROWS. Vinton and Coy. 21s.

In this book the author traces the development of the Dairy Shorthorn from the time of the Collings brothers to the present day. To the breeder of Dairy Shorthorns, he has a fascinating story to tell, and he has gathered together much interesting information on the breeders, the herds and the individual animals which have occupied the front of the Shorthorn stage from 1784, when Charles Colling bought his first Shorthorn cow and Robert Colling bought the famous bull "Hubback". His account of the dealings between these early breeders, Thomas Bates and others, is pleasant reading and is easily understood by their successors some 160 years later.

A full account is given of the pioneer work of Richard Stratton which led to the formation of the Dairy Shorthorn Association in 1905, and special attention is paid to the four herds at Tring, Cranford, Kelmscott and Babraham, which are rightly credited with playing a great part in the establishment of the Dairy Shorthorn type. The owners of these herds were also enthusiasts for milk recording, and the publication of periodic statements of the yields of the individual cows in their herds did much to draw attention to the value of recording in the breeding of dairy cattle.

The second half of this book consists mainly of pen-pictures of numerous herds which have contributed to the advancement of the breed. Some of these have been dispersed during recent years, and others are still contributing to breed history. Present-day breeders will find much useful information on how these herds have been built up, together with details of the Dairy Shorthorn families they developed. Sometimes the degree of perfection claimed for these families was not maintained in succeeding generations, but the details given on the breeding and showyard successes of individual bulls and cows make these chapters a convenient reference for breeders of today and tomorrow.

It may be that some readers will consider that family names are given too much prominence. Sinclair, in his History of Shorthorn Cattle, published in 1907, and under whom the author worked for several years, discussed critically the practice of recording pedigrees through the female line, and Mr. Burrows might have given a summary of the present-day views on this subject. An up-to-date statement of the "points" of a Dairy Shorthorn would have been a useful addition.

The book also contains 19 photographs of famous bulls and cows and is well indexed and easy to read.

J.M.

Food, Farming and the Future. FRIEND SYKES. Faber. 21s.

Some people write books to make money, others because they have a message to pass on, and yet another group for reasons of urgency—or as Scripture puts it, because of "fire in their bones". Friend Sykes's work falls obviously into the latter categories, and no one can deny that he has not the necessary experience or that he does not appreciate all the factors involved.

The book is one that every true student of agriculture should read with an open mind. After all, Mr. Sykes has really done what he says he has. He has wrought a transformation at Chantry ; he has turned the "sandy waste" into a highly productive Eden—even if he has rejected the fertilizers, the insecticides, the fungicides and the like.

Mr. Sykes believes in what may be called a sane, controlled use of compost, plus the deep-rooting, four-year-leys and not forgetting the sewage. He knows the importance of soil texture but insists that this is not all, for there is need to feed the "denizens of the soil" as well as the earthworms. He stresses the value of having the organic matter, and as a result the humus, in the top few inches of the soil where oxygen is available to the micro-organisms.

Thus the surface cultivations are linked with the natural work done lower down by the deep-rooting leys. The picture is completed by tripod grass drying, intelligent silage-making and the saving of his own, compost-grown seed. Here is a belief in the germ of a seed inheriting "all the circumstances" of the soil in which it grows. Many people will cross swords here !

However, the book is well written, it is sincere, it rings true, and the message is one that all should heed. Even those who disagree will find the reading stimulating, for it is a well balanced book.

W.E.S-C.

The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms. T. WALLACE. H.M. Stationery Office. 35s.

When in 1943, the Agricultural Research Council published the first edition of Professor T. Wallace's book on mineral deficiencies in plants, the demand exceeded all expectation. A supplement of additional coloured plates appeared in 1944, and the second edition was then put in hand. The new edition, long overdue and awaited by technical officers and farmers, not only in this country but in all parts of the world, is a marked improvement on the original. The design of the book is generally unchanged, except that 312 coloured plates (209 before) are displayed in order of crops and not, as with the first edition, in order of separate deficiencies. This is an advantage, since it is now easy to look up and observe the appearance of a particular plant under the duress of different deficiencies and other nutrient complications.

The book has been written and illustrated for advisers, farmers, market gardeners, and fruit-growers. A wide range of crops is covered, including cereals, brassicas, root crops legumes, miscellaneous vegetables, hops, tomatoes and fruit. The text, as previously, treats the science of crop nutrition in relation to the soil in a lucid and practical way. Advances in the realms of plant nutrition have been incorporated both from physiological and applied aspects. In describing methods of determining mineral deficiencies in crops, an account is given of the comparatively new technique of estimating the nutrient content of fresh material by rapid chemical methods.

Although the text is most readable and worthy of careful study, the coloured plates are so good as to be almost self-explanatory. Some crops such as cereals, cauliflower, sugar beet, and tomato are illustrated more extensively than others, but such differential treatment does not call for harsh criticism. Most of the plates deal with the appearance of the leaves and the habit of the plant or crop when subject to the deficiencies of the major and trace nutrients. One new feature, however, deals with the problems associated with excesses of nutrients and other elements and their effect on the visual appearance of the plant. An understanding of the soil acidity complex and its effect on the growth of plants can be more easily understood by realizing that symptoms of a deficiency and an excess can be seen on one and the same plant. Likewise, the interaction of nutrients, in so far as they influence the appearance of the plant, are illustrated for one of two crops.

In a world suffering from a declining food supply, this book, full of practical help, should be in the hands of all whose lives are devoted to growing better crops.

W.P.

English Husbandry. ROBERT TROW-SMITH. Faber. 18s.

The historian of farming suffers peculiar difficulties. His subject is immense and painfully incoherent, some parts of it being documented to excess, and others practically unexplored. Further, Lord Ernle, the author of the classic agricultural history, died in 1937, and his book, despite skilful revision, is now in certain respects incomplete or out-of-date, so that it has become an essential yet potentially dangerous guide. Mr. Trow-Smith is aware of these perils. He has limited his scope, in general, to the art and science of agriculture in the field ; he has read widely if somewhat unimaginatively ; and he treats Ernle's masterpiece with caution as well as respect. The result is a readable narrative which describes, in outline, the development of our farming industry from the earliest times to the present day.

The general story is familiar, indeed rather too familiar, for the author has apparently deviated little from the standard books and he ignores certain interesting episodes, notably the agricultural survey attempted by the Royal Society in the 1660s, which have been discussed only in periodicals. But his summary of modern information on "prehistoric" and Roman farming in this country is particularly valuable. So is the evidence he accumulates against the traditional concept of the "self-sufficient" economy of the Middle Ages which the older writers so exaggerated. He quotes, for instance, at some length from the findings of Eileen Power on medieval sheep farming and emphasizes the economic importance of the "cash crop" which these old flocks carried on their backs—though, surprisingly, he fails to mention the equally effective but older work of Gras on the corn-production side of the same basic argument. The book continues by way of the Agricultural Revolution and the High Farming to the present day and ends with a lucid and balanced account of farming development in our own time.

The book is written in a pleasant style and contains interesting illustrations and a bibliography. It also carries, unfortunately, certain defects which seriously reduce its force and value. Firstly, the approach is purely chronological and there is little analysis or explanation of events. Secondly, the material, which is derivative, is too often incorporated without sufficient editing, criticism or assessment. In short, this book is a compilation or a record rather than a history in the true sense of the word. Nevertheless, it can be regarded as a good general introduction to our farming past and will also serve as a useful modern supplement to Ernle's standard work. *N.H.*

Farm Structures. H. J. BARRE and L. L. SAMMET. Chapman and Hall. 56s.

This is one of a series of textbooks intended for American students of agricultural engineering, who are expected to obtain some knowledge of farm buildings even though they will not become specialists in the subject. About a third of the book is therefore devoted to elementary building construction and structural design with particular reference to farm buildings. While the section on building construction treats the subject a little superficially, no doubt due to pressure on space, the section on structural design is admirable as might be expected from the pens of two engineers. There is also an excellent section on elementary physics as applied to building construction. The description of the theoretical causes of condensation on walls and roofs and ways of controlling it is particularly good, though much of it is of course only applicable to American conditions.

For those in this country concerned with farm building design, the most interesting chapters are those dealing with farm buildings themselves, though unfortunately only buildings for housing dairy cattle and poultry and for storing vegetables and grain are considered. The approach adopted is to consider first the basic physiological reactions of livestock to their environment and from this to try and design buildings which will provide satisfactory environmental conditions. The authors, however, seem to experience much the same difficulty which has been found in this country of converting the limited knowledge of physiological requirement into terms of building construction.

The same approach is followed in the case of crops and the storage to be provided for them. There are also chapters on farmhouse design, analysis of costs, both capital and maintenance, and the design of farmsteads and individual buildings for work simplification. Other subjects such as the mechanical equipment needed in and about farm buildings are not included as apparently they will be covered by other books in the series.

This book is principally of interest in its method of approach to the subject, called functional analysis by the authors, which might well be copied in this country.

A.J.L.

Leather and Craftsmanship. J. W. WATERER. Faber. 12s. 6d.

My most pungent recollection of leather is sailing across the Bight of Benin in a ship carrying a cargo of raw hides. The hatches were, I think, inadequately battened, the wind contrary and the heat intense. Mr. Waterer in his writing and lectures on leather has done much to sweeten, if not supplant, that memory. In a larger and earlier book, he encompassed most of what is known as leather. Now, in *Leather and Craftsmanship* he gives us a quick review of leather in all its aspects—and there are many—from paleolithic to present times.

The subject is as fascinating as it is diverse; a quality reflected in the construction of the book. We are whisked from such pedestrian trappings as cracowes and poleynes to the mysteries of water budgets, cruppers and other remarkable triumphs of *cuir bouilli*. In this imposing array of leather craftsmanship two particularly English achievements stand out, the long boot and the hunting saddle which still goes abroad to proclaim the excellence of our skill.

Mr. Waterer follows this random survey with some pertinent observations on craftsmanship and its contribution to human happiness and achievement. He also has some hard things to say about how we spent our leisure—in ways that add little to the sum of human endeavour. A glance through the illustrations at the end of this book would convince even the hardened libertine that the leather craftsmen have found and given pleasure in the practice of their skill. They have shown us how a fine material, stout yet pliable, can be put to a hundred useful purposes and, in the process, become objects of great dignity and beauty. A set of harness, a calf-bound book, diced and gold tooled, or a medieval reliquary case incised with the most sensitive flowing decoration, owe much of their merit to the skill and understanding with which the material has been used.

Countrymen are, perhaps, more sensitive to the pleasure of using raw materials in ways to which they are best suited. Some may even be inspired by Gordon Russell's excellent foreword in this book to try their hand in leather. All will be grateful to Mr. Waterer for this introduction to a fine craft and for his reflections on the value of skilled craftsmanship in a machine age. There is yet hope that the hand which daily minds the machine may find relaxation in craftsmanship of a high order.

J.N.W.

The Vitamin B Complex. F. A. ROBINSON. Chapman and Hall. 60s.

To write exclusively on one particular group of vitamins may evoke criticism, yet the impossibility of adequately surveying the whole field of vitamins within the compass of a single volume will be obvious to every chemist, biologist, and nutritionist. The author, a specialist who has been actively engaged in the isolation, production and assay of the most important members of the vitamin B complex, fully substantiates the arguments in favour of restricting the field of survey ; indeed, this monograph sets a very high standard for anyone electing to follow his example.

The selection of material and the form of presentation is admirable. Each member of the complex is accorded a separate chapter, with sections devoted to the isolation of the vitamin, its chemistry (including constitution, synthesis, properties, estimation, etc.), the occurrence of the vitamin in foodstuffs, the effect of deficiency in man and animals, metabolism, intestinal synthesis (where this occurs), human and animal requirements, pharmacology, function, the importance in the nutrition micro-organisms, the effect on higher plants, the requirements of insects and, finally, there is a section dealing with the analogues of the vitamin. Historical aspects are adequately covered and there is a wealth of references to the original literature. The arrangement adopted helps to remind the reader of the similarities and close relationship of the members and at the same time permits easy reference to any particular aspect of the subject. Some may regard as intruders such substances as inositol and choline, which occur in the body in large amounts, compared with other members of the vitamin B complex, but, apart from other considerations, their inclusion is justified under the shroud of complexity implicit in the title of the monograph.

An astonishing amount of information has been crammed into the 629 pages of reading matter ; in addition, there are author and subject indexes covering 58 pages. Much still remains to be discovered and explained before the intricacies of the vitamin B complex are finally elucidated ; meanwhile this book should prove to be the standard work on the subject. *E.L.S.*

Insects and Hygiene. J. R. BUSVINE. Methuen. 30s.

The sub-title of this book—*The Biology and Control of Insect Pests of Medical and General Importance*—while more informative than the title itself, still fails to provide a guide to the ground actually covered. Dr. Busvine's book is no less than a manual, almost encyclopaedic in character, and relates to the control of all insect pests in Great Britain other than those attacking growing crops and livestock. As explained in the preface, it is intended primarily for the information of technically-trained people, such as Medical Officers of Health, Sanitary Inspectors and Commercial Pest Control Officers, who are likely to be confronted with problems concerning insect pests of domestic and medical importance.

The relationship between insects and hygiene is discussed, and this is followed by sections on the structure, classification, anatomy, physiology and ecology of insects, all dealt with in simple terms. The next part of the book is devoted to control matters ; the principles of control are discussed and particular problems dealt with. The scope of the book is wide—house-flies, blow-flies, blood-sucking flies, parasites of humans, clothes moths, carpet beetles, timber borers, stinging insects and, finally, various "nuisances", including woodlice and spiders.

Some of the insects listed are not usually regarded as coming within the field of hygiene, but their inclusion certainly adds to the usefulness of the book and should help to make it valuable to a wide variety of readers.

At the end are two appendices. The first, biological, includes several keys, taken from other publications, for use in the identification of various insect pests. The other, a chemical appendix, as well as giving notes on chemical techniques for the estimation of insecticides, contains a most informative index of insecticidal substances in common use.
J.W.E.

Chemical Control of Insects. T. F. WEST, J. E. HARDY and J. H. FORD. Chapman and Hall. 15s.

The books in the series "Frontiers of Science", of which this is one, aim at showing scientists what is happening in subjects other than their own; at the same time, they attempt to make clear the latest lines of research in the subject concerned to those who have only an elementary background of scientific knowledge.

The subject matter of this volume is dealt with essentially from a chemist's viewpoint. Individual chemical groups of insecticides are covered separately and no attempt is made to classify them according to their spheres of application or modes of action. Chapters on nicotine, petroleum oils, coal tar derivatives and pyrethrum are typical examples. Each contains a digest of information and, as one or other of the authors has specialized

knowledge of one or more of the materials, these chapters will justify the inclusion of the book in many a reference library. For this purpose, it is a pity that no work appears to have been done on the book since 1947, with the result that a number of items are already out of date.

Two chapters deal, very inadequately, with repellents and with fumigation respectively. An attempt has also been made to give an overall picture by including two introductory chapters dealing with insects and with general principles of pest control. Although its place in a book of this title might well be challenged, there is also a short section on weed control.

I am doubtful regarding the compatibility of the objects already referred to. As a result, the book appears to be directed in parts to the layman and in parts to the trained chemist. Nevertheless, particularly in view of the contents of the chapters on individual materials, it should warrant a place in the library of both—the interested layman and the specialist in pest control.

E.E.T.

Milk Testing. J. G. DAVIS. Dairy Industries. 15s.

Dairy technical literature in this country has, for a long time, lacked a good text-book on general milk analysis. The deficiency has now been remedied, for indeed this excellent publication covers all the necessary information required for the routine control of raw, pasteurized and sterilized milk, and cream.

The author deals first with methods of sampling, and, in turn, with physical, chemical, biochemical, bacteriological, and miscellaneous tests. A short section follows on the subject of cream and homogenized milk and other products, and a final useful chapter on the organization of the dairy control laboratory.

The material in each section is arranged in alphabetical order ; thus, details of the determination of albumen are given before those for fat or solids-not-fat, and while this makes for easy reference, it may, at first, be confusing to the chemist, who is more familiar with the procedure, observed in most text-books, of first giving details of the more frequently required techniques.

A praiseworthy principle is followed throughout the book : the object of any particular determination is discussed and the principles underlying the technique fully described before the actual details of the method are given. The worker is thus able to obtain a proper understanding of the method he is using and appreciate its limitations. The methods described are those generally recognized as standard, and if the details are observed they should give no trouble in the hands of the average worker. The book is well illustrated and remarkably free from errors. The author has unquestionably succeeded in producing, as he intends, " a practical manual for the bench worker".

C.A.S.

Parasitic Animals. GEOFFREY LAPAGE. Cambridge University Press. 21s.

Dr. Lapage's book is the first of its kind in the English language and, as such, satisfies a long-felt need. It is designed primarily for students and teachers of biology, and provides an excellent introduction to the study of the many fascinating aspects of parasitology. The book is written in a concise and polished style, the use of obscure scientific terms has been avoided without in any way " talking down " to readers. Consequently, it is a thoroughly readable book which should have a considerable appeal to those interested in animal life.

The author contrives to cover a tremendous field in just over three hundred and thirty pages. He explains the scientific meaning of the word "parasite," and describes the ways in which various parasitic animals find their hosts ; how they get inside them ; and, once inside, how they move about. He devotes two chapters to descriptions of twelve representative life histories—including malarial parasites, roundworms, tapeworms, flatworms, and insects—and illustrates each with an ingenious diagram. Dealing with the more general aspects, Dr. Lapage describes how this very specialized existence has modified some parasites to such a degree that, for much of their life, they bear no resemblance to their free-living relatives. He recounts many of the effects they have on their hosts, the diseases and suffering they cause, and touches briefly on many other aspects of the dynamic relationship existing between the parasite and its host.

The book is illustrated by 48 excellent original photographs and 65 text figures, many of which are taken from standard text-books, some unfortunately suffering from being too drastically reduced. There is an extensive subject index, and the book is adequately cross-referenced, although it is regrettable that there is no bibliography. Many readers will surely and their interest so stimulated that they will wish to pursue the study and would appreciate some guidance for further reading.

S.W.

BOOK REVIEWS

Fungi—Friends and Foes (Science in Action, No. 2). A. F. PARKER-RHODES. Paul Elek. 12s. 6d.

As everyone knows who has made the attempt, it is not easy for a scientist to write on his special subject in simple language and at the same time convey accurate impressions to the "lay" reader. This little book is described on the jacket as " an outline sketch of what is known about the Fungal Kingdom," a somewhat grandiloquent claim to which, I think, the author himself would hardly subscribe. What Mr. Parker-Rhodes has attempted to do is to give, in the space of 130 pages, a readable account of the nature of Fungi and some of their activities. Under such chapter headings as " Burial of the Dead," " Undertaker turns Grocer," " Robbery," " The Virtuosi," etc., he deals with the activity of saprophytic fungi as scavengers, with the development of parasitism and symbiotic relationships such as mycorrhiza, with crop hygiene, and with the uses of fungi as food for man, in industry, and medicine. Inevitably, in spite of the popular approach, he has been obliged to use a number of technical terms, some of which (but not all) are explained in a glossary. On the whole the author has succeeded in conveying a good deal of information in a readable fashion, but the presentation suffers at times from over-condensation and too much " simplification".

For further reading the author has suggested a few books, but the list is a curious mixture and very inadequate. He has, moreover, himself put difficulties in the way of a student wishing to consult these books by using, without explanation, generic names of fungi which are not commonly used in this country, and some of which, such as *Suillus*, are far from being generally accepted.

Elementary Genetics. WILMA GEORGE. Macmillan. 10s. 6d.

Bateson, who coined the word "genetics" in 1906, defined this new science as one whose " labours are devoted to the elucidation of the phenomena of heredity and variation ; in other words, to the physiology of descent". Interest since then has been concentrated mainly on the laws of inheritance (Mendelism), but genetics must be permitted a much wider range and embraces heredity, embryology and evolution. Miss George stoutly defends this concept. She trips lightly through the field of Mendelism (with one rather unexpected stumble while discussing sex-linkage in fowls); but she makes her readers drink deeply of the waters of cytology, biology, and biochemistry, and almost presuades them that genes, viruses, and nucleic acid are but one and the same thing.

The word "elementary" in the title is mildly provocative. It is essentially a comparative term and may therefore be justified on the grounds that (a) the work as a whole is based on Professor Waddington's older, but more detailed, *Introduction to Modern Genetics* and, (b) the section on Mendelism is indeed simple. The rest of the volume, however, though well written and illustrated, is on a higher plane, and will appeal mainly tc students who have already acquired a sound knowledge of biology and organic chemistry.

G.E.M.

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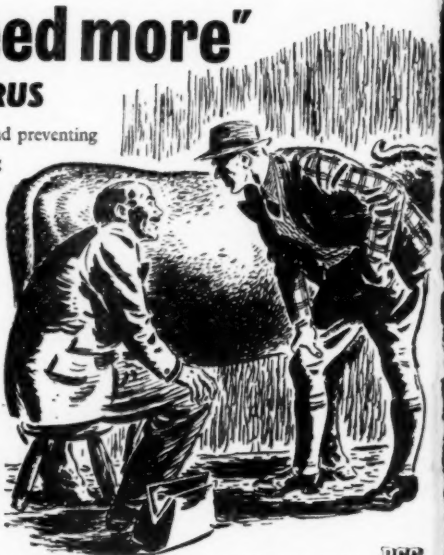

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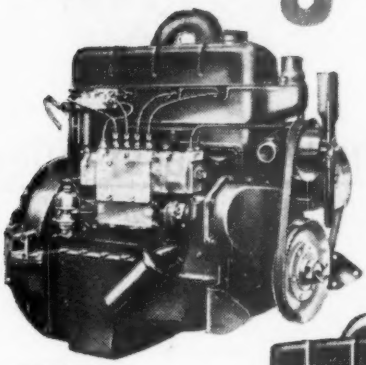

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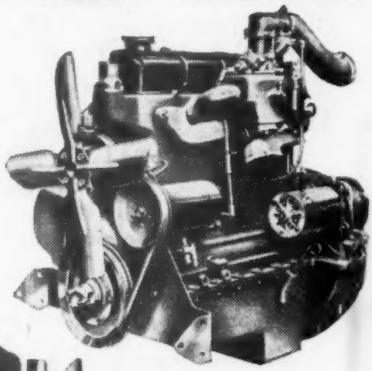

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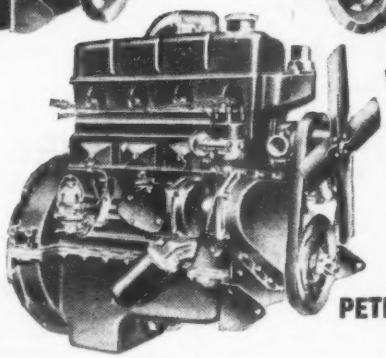

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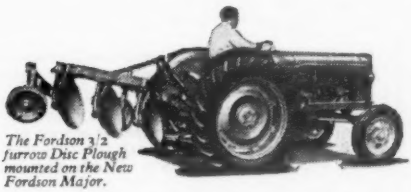

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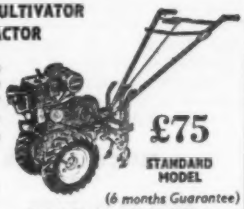

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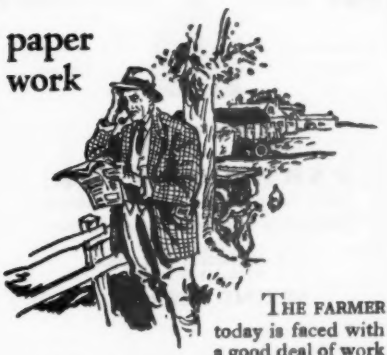

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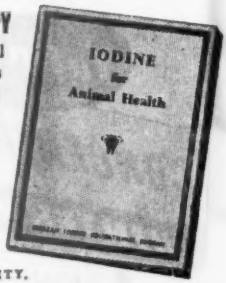

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